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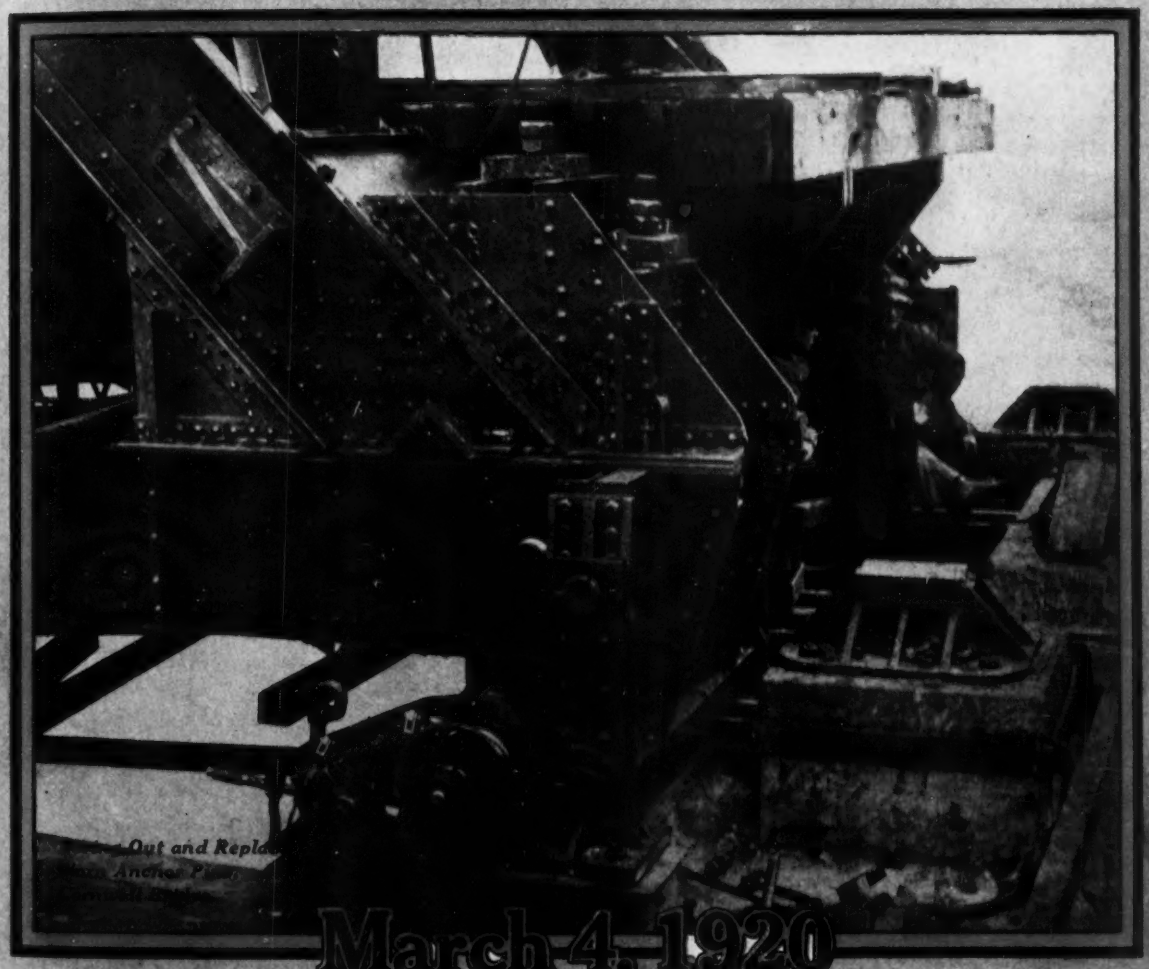

March 4, 1920

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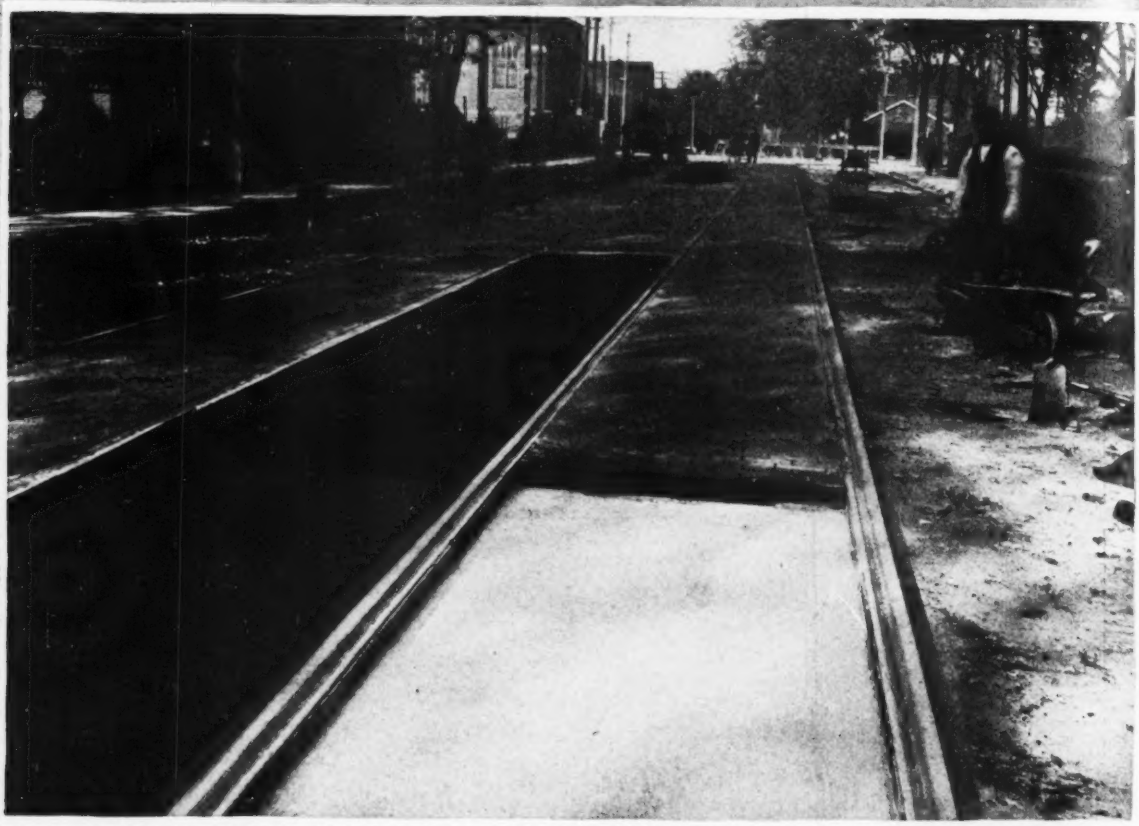
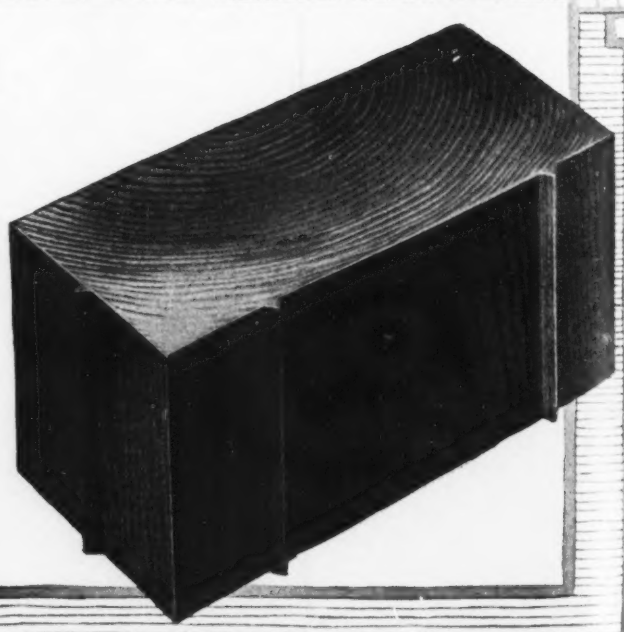


The Lug a Factor of Safety

Kreolite Lug Wood Blocks were selected in preference to rectangular blocks for paving between the rails and the dummy on Herkimer Street, Hamilton, Ont, because the Lug Block pavement automatically takes up all expansion; no danger of rails being forced out of alignment, or of the pavement buckling between the rails. As Lug Blocks give a good foothold horses will not slip and block traffic. Lug Blocks are safety blocks. They provide a grip for wheel chains and help prevent skidding.

The Jennison-Wright Co.
79 Kreolite Bldg., Toledo, O.



A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—James H. McGraw, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING
AND CONTRACTING

E. J. Mehren
Editor

Volume 84 — NEW YORK, THURSDAY, MARCH 4, 1920 — Number 10

Roads in the Spring Break-Up

REPEATEDLY we have called attention to the need of legislation which would enable state highway departments to rule heavy vehicles off the roads during the period when the frost is coming out of the ground. No lengthy argument is necessary on the subject. All engineers and all intelligent users of the highway appreciate the need of this public power. What is demanded now is action. Many state legislatures are in session. Where the power to make these rules is not now vested in the state highway departments, the legislation should be forthcoming at once. Only so can we conserve the present highway investment.

International Road Congress

IN THE first bulletin of the Permanent International Association of Road Congresses published since 1914, the outbreak of the war, the question is raised as to where the next International Road Congress should be held. Members have suggested either Italy or the United States. With the tremendous progress we have been making in highway building and the intensity of interest displayed therein, America would very properly be the place to hold the next congress, in 1921. France, Belgium and England, successively, have entertained the Road Congress in their capital cities. We should certainly take pride in becoming the next host. Unfortunately, however, we are in an embarrassing position—and have been at the three previous International Road Congresses. Despite the fact that, among other countries, Belgium, Cuba, France, Great Britain, Italy, Japan, Mexico, Norway, Portugal, Spain, Sweden, Switzerland, are members of the association, the United States has never taken membership. Consequently, it has not been represented by delegates at the Congress, though engineers from the United States have been welcomed to the meetings as individual members. Our holding aloof is a reflection upon us and an indication of the insularity that, in the past at least, has marked our thinking. The rules of the congress and of the association provide that each government shall have a right to one representative for each 1,000 francs of annual subsidy, provided, however, that the number of representatives from any one government shall not exceed fifteen. In other words, for a paltry pittance of $3,000 the United States refrains from official participation in the work of this important organization. We would suggest that engineers in this country who believe that the United States should take membership would do well to express their views to Thomas H. McDonald, chief of the Bureau of Public Roads, for, though we have had no conference with Mr. McDonald on the subject, it would seem proper that he, as the director of the highway activities of the Federal Government, should be the medium through which the voice of the engineers of this country should be expressed. We have no doubt that if this matter be properly presented Congress will vote the necessary funds. Once a member of the association, we will be in a position to extend an invitation to have the next congress held in this country.

Task Ahead of Railroad Engineers

WHEN the American Railway Engineering Association met last year there was doubt and apprehension as to the future of the railroads. In less than two weeks it will meet again at Chicago to discuss many of the engineering problems that must be worked out, now that private enterprise is to prevail. In the transition there are changes in titles but fewer changes in duties. The opinion is almost unanimous that, while serving the Government, railroad engineers performed notable and conscientious service in maintaining the properties in as good condition as limited funds and materials permitted. But the roads must be brought back to prewar efficiency as to their physical condition. As soon as funds are available in ample amount the engineering forces will have to assume a tremendous burden. The realization of this will undoubtedly be in the background of all the proceedings at Chicago.

Back to Private Operation

A POINT in the history of the country's economic development was marked by the return of the railroads to private operation last Monday after more than two years of Federal control. The emergency step taken during the war thrust the advisibility of Government ownership and operation to the fore. The proposal has been rejected. The railroads have been returned under a law that gives hope of an era of successful private management and development. Although portions of the law have been widely misrepresented, it is clearly anything but a socialistic measure, but rather an expression of the country's opposition to Government ownership.

A Society of Military Engineers

A SOCIETY of American Military Engineers is being organized. Its membership is open to engineer officers and to civilian engineers formerly in the military service in any arm, branch or rank. "In the interests of the national defense to promote the efficiency of the military engineer service . . . and to foster relations of useful interest between the engineering profession in civil life and that in the military service"—this its provisional constitution declares to be one of its objects. The organization is more fully described in the news columns of the Feb. 19 issue. Based upon the latitude of eligibility and the objects cited, it is safe to predict a large membership. Certainly the attainment of those objects merits the support of all who are eligible; indeed, their attainment

is the common desire of all civilian engineers who have worn the uniform. None but has seen room for improvement in the engineer service—lots of it. Having the opportunity, each would contribute his best bit to such improvement. The new society might be the opportunity.

Soldier-Civilian Co-operation

ENGINEER support of our combatant arms in France has been praised more highly, perhaps, than that of any other service. Engineer service was ready when the need came. *But* the need did not come until a year after war was declared. It took the fighting arms that long to get ready; and it took the engineers that long. It will not take the former that long again, but it will take the engineers that long, relatively, unless the Corps of Engineers and civilian engineers of the type whose ability and training were found indispensable in war co-operate in time of peace to formulate engineer organization and policy for the eventualities of war. Had this been done before 1917 the engineer service could have been ready in half the time. It has been a lesson; let us assume it has been learned. Then, to co-operate. Through the Commissioned Reserve? No. The Reserve has essential uses, but it has not the machinery for the policy-forming co-operation of the soldier and the civilian engineers, due, among other things, to the differences in rank between members of the regular army and officers from civil life. The Society of American Military Engineers, if it is managed as a democratic organization in which rank is leveled and questions decided on their merits and not on the rank of their proposers, has possibilities.

Hoover on Railways and Shipping

HERBERT HOOVER'S discussion of the railway and shipping problems, in his inaugural address as president of the American Institute of Mining and Metallurgical Engineers, printed last week, is characterized by hard, common sense and a recognition of the many factors involved. He presents strongly the weakness of Government operation, but points out that with the railroads now returned to private ownership there will be demanded a high degree of efficiency in operation, the enlistment of the good will of the employees and protection of the public. He does not blink the fact that the railroad operators have a very difficult situation before them. On the shipping situation, we have not seen in so small a compass so excellent a presentation of the complexity of the problem. He emphasizes the difficult position of the Government in its inability to bargain over cargoes and traffic. On the other hand, he points out the inevitably bad consequence of inability so to conduct its shipping business. But that is only one side of the case. The other, the demobilization of the present shipping into private hands, is beset by difficulties involving price, the maintenance of a shipping industry, and the preservation of our shipbuilding organizations. All of these things, so clearly put, should stimulate the interest and the thinking of all citizens, particularly of engineers, to whom Mr. Hoover addressed himself in his remarks. If we could only say that the thinking illustrated by his address was representative of that of engineers at large, who could estimate what our influence would be in public affairs? There are few Hoovers but the Hoover mark is one to shoot at.

Our Own Social Philosophy

NOT less striking than Mr. Hoover's discussion of the railroad and shipping problems is the soundness and the sureness with which he approaches the problem of industrial relations and the fundamentals according to which we must solve our national problems. He goes to the core of the matter of industrial relationship when he says that we must re-establish "that personal co-operation between employer and employee that was a binding force when our industries were smaller." In his emphasis upon the need of solving our problems in accordance with our own national ideals and our own social philosophy, he will strike a kindred chord in the heart of every loyal citizen. Our philosophy is based upon the conviction that there should be equal opportunity for all. We may not have fully secured that equality of opportunity, but nevertheless the swings back and forth in the relations between capital and labor have been efforts to realize that ideal. In these sentences he interprets the kind of State we have been trying to develop: "A society that is based upon a constant flux of individuals in the community, upon the basis of ability and character, is a moving, virile mass; it is not a stratification of classes. Its inspiration is individual initiative. Its stimulus is competition. Its safeguard is education. Its greatest mentor is free speech and voluntary organization for public good. Its expression in legislation is the common sense and common will of the majority." The State, in the American conception, should step in to safeguard the interests of the many against the few, and should not do that which private initiative and organization are capable of accomplishing. Mr. Hoover rightfully concludes that if we cling to our national ideals "it will mean the final isolation and the political abondonment of the minor groups who hope for domination of the Government, either by 'interests' or by radical social theories.

Concrete Ships Still Experiments

EVEN in the crowded days of 1918 when the fate of the world seemed to hang on more ships and all possible materials and methods were being urged for the construction of the needed bottoms, no one proposed the concrete ship as anything more than an experiment. Today when emergency measures are no longer required and when five large concrete steamers are on the high seas and ten more are well along toward completion their experimental status still exists. That is the main deduction from the Concrete Institute report printed last week. Time only can prove whether concrete will become a fitting material for ship construction, but several things have been learned. There appear to be no difficulties in design and construction which cannot be overcome; and the big ships are seaworthy. So much is in favor of the concrete ship. On the other hand, there is no such saving in cost and speed of construction as was expected and the ratio of dead weight to carrying capacity, even with a light weight aggregate, is much higher than anticipated. Furthermore, there are dangers in the thin shells—thin, that is, for a concrete member—because of the case of puncture or rupture by the unavoidable blows of other vessels or marine structures. Certainly experience has shown that the steel ship is in no danger of being supplanted, but, on the other hand, it has justified the enthusiasm which advanced the concrete ship in the emergency of war.

Mixing Cobbles in Concrete

LARGE-SIZE coarse aggregate mixed in the batch is not common in concrete practice but it has been used. In fact in mass work, for dams especially, there are several precedents for the 6-in. cobbles included in the concrete for the Warm Springs dam described on another page. The knowledge of such use, however, is not widespread nor the integrity or economy of the concrete so made established. According to Charles H. Paul, experiments on cobbles in the mixer were tried at the Arrowrock dam as far back as 1911 and proved so satisfactory that the method was used—and successfully—in practically all of the 600,000 cu.yd. of concrete for the dam. In *Engineering Record*, May 1, 1915, there is in article by E. O. Keator advocating the more extensive use of large size—even up to 8-in.—aggregate in the mixer and citing half-a-dozen instances of the satisfactory use of such stone. Nevertheless, most concrete men while not necessarily condemning such a practice would feel that in using it they were treading a pioneer path. There are some obvious advantages of including the admittedly useful plums in the mixer. There should be economy in placing and an insurance of complete coating by the mortar and apparently there is no difficulty in plant manipulation nor any undue wear on the equipment. For mass work, therefore, it deserves more attention than it has attracted.

"Hylan Swings a Pick"

SNOW removal was commented on extensively in this journal Feb. 19, and the extensive use of contractors' equipment was advocated. Equipment, though, unaccompanied by brains and the right point of view will be of no value. The streets may be cluttered with steam shovels, the avenues choked here and there or at the unloading stations with motor trucks—and nothing be accomplished. During the storm in New York which tied up traffic for nearly two weeks one steam shovel was employed, but between trucks it waited idle for twenty or thirty minutes. The trucks got into traffic jams on the way to the unloading station. Brains and the right point of view would have assigned certain streets for the trucks to travel over and kept all other traffic off those streets. Speaking of New York conditions, however, the last storm plainly demonstrated that both brains and point of view are missing. The mayor tried to clear the streets by proclamation. His efforts may be well epitomized in one of the newspaper headlines, "Hylan Swings a Pick." Compared with the magnitude of the task that action was symbolic of the helplessness of the city's snow cleaners.

Completing the Tunnel Enterprise

VERY properly the report of the New York-New Jersey Tunnel Commission has excited a great deal of interest in the metropolis and in the adjoining communities of New Jersey. If the interest be taken as an index of intent, one can expect action on the tunnel project within a reasonable time. It is, therefore, worth while putting on record and emphasizing that the trans-Hudson traffic question includes more than the river crossing. Only part of the interchange of persons and goods has its western terminus on the river flat occupied by Hoboken and Jersey City, and the requirements of the case are not fully met unless convenient means are provided for linking up the Hudson crossing with highways leading to Newark and farther on to Trenton and Philadelphia. A rock ridge several hundred feet high bounds the river flat on the west. As now planned the tunnel makes no provision for passing this barrier except by climbing over it on a steep-grade road. From the viewpoint of state or national interests—and we believe, even from a strictly local viewpoint—the Hudson crossing will be incomplete until it is extended to a terminus on the western side of the Palisades barrier and carried across the Hackensack meadows to a junction with the national road system at Newark. Now that the river problems are disposed of, this second part of the enterprise will shortly call for consideration.

Curtailed Highway Construction, Shall It Be Voluntary or Enforced?

THE post-season ambition of 1919 to carry through in 1920 a drive to complete enormous mileages of paved highway has been moderated. Few states now speak of building a much greater mileage in 1920 than they built in 1919, except the states which this year undertake hard surface construction for virtually the first time. Curtailment of the program until very recently has come from the growing realization that enough contractors were not available and that means of transportation for materials were lacking to make extraordinarily large mileages possible. Now the influence of high bids is also being contributed. One can foresee, from whatever viewpoint he takes, only the forced limitation of highway construction to very moderate mileages compared with the mileages for whose construction money is available.

An important question, then, is squarely before public-roads officials. Shall they persist with an extensive program which is certain to be curtailed in haphazard manner as conditions may dictate, or shall they abandon the present program and come to one less ambitious but curtailed in a logical and systematic manner? Briefly, shall the curtailment be voluntary or enforced? Theoretically, the choice of alternatives appears plain. Practically it is difficult to choose.

Many promises of highways to be improved promptly stand to the debit of highway officials. The public which has appropriated money in astounding amounts on the strength of these promises regards them jealously. The reaction of this public to an announcement that it must wait five years or longer for what it expected to get in three years or less is reasonably to be feared. To announce that mileages promised are to be redistributed involves even greater possibilities of wrath to come. Obviously it will be bad for all to challenge a reaction which will turn the public against highway improvement. The temptation is to drift. Highway officials are now drifting. Is it a wise policy?

Has the time not come for the highway officials of the country generally to announce the desirability of reconstructing our highway program? Is it not the part of wisdom for them to go back to the people frankly with an explanation of the conditions and a modified program of mileages, distribution and period of construction? Straightforward presentation of these facts and of the economic advantages of a reconstructed program are likely to strengthen rather than weaken highway engineers and the cause of improved roads with the public.

There should be a revised program of highway construction. Fundamentally it should provide first that the rate at which improvements are placed under con-

tract be limited to the capacity of the available construction agencies with the maintenance of reasonable competition; second, that the economics of road types, including maintenance requirements, be reviewed in the light of present costs and a reselection be made according to the conclusions arrived at.

These are radical proposals *but the conditions warrant radical action.*

Present Attitude of Contractors

THERE is plainly a declaration of independence in the new attitude of contractors in discussing specifications. The substance of this change is sensed more clearly than it can be defined but its spirit challenges old practices so sharply that they must look to their defenses. The privilege, long ago appropriated by the engineer, of determining, without consulting him, the obligations of the contractor in building engineering works, is being squarely attacked.

Indicative of the new attitude of contractors is the fact that protests against requirements considered to be unfair and pleas to the engineer to give these protests charitable consideration, are being replaced by evidence of unfairness and by argument that through unfairness the financial interests of the owner suffer equally with the profits of the contractor. The article on p. 457 of this issue is an excellent example of this constructive discussion. Candid statements of facts like those of R. G. Collins, Jr., in the *Engineering News-Record* of Jan. 15, 1920, p. 122, are another method of attack. In effect the owner is being awakened by evidence and by an appeal to reason to the truth that he pays a high price for every unfair requirement in or interpretation of specifications.

Conditions which are plain to all discourage the notion that the present attitude is likely to be temporary. Contractors are becoming more thoroughly organized and the strength of organization is being reflected in increased courage in calling for reforms in contracting practices. Large contracting organizations, directed by business and construction experts and employing large amounts of capital, are becoming increasingly dominant in the construction industry and with their growth is growing the determination to enforce the consideration of just reforms. Even in smaller organizations the same determination is begotten of the increasing extent to which engineers are taking control of their technical management. Finally the determination to demand reforms is given power by conditions which are unique in engineering construction.

There is more construction pending than can be carried out by the contractors now in business. In highway work the condition is already acute. Large construction programs are certain to develop in the next two or three years on the railroads, in water power, buildings and public works. The shortage already apparent will be intensified.

A condition, therefore, is at hand which gives contractors power to choose the work which they will undertake. Naturally they will exercise this privilege by refusing contracts which are least to their liking.

Co-operation and not resistance by the owner is the wise attitude, and this the engineer should encourage. On the other hand, the contractors themselves face a danger. Apparently they now have the whip hand and can dictate the terms under which they will work. Will they be drunk with power and become unfair? If they do they will rue the day. Calling for fairness they must be fair. Only so will justice be done.

Then, too, they must recognize that much of the complaint about unfairness is due to interpretation—a matter not possible of certain correction in all cases. In other words, it is absolutely impossibble to define everything by specification—for engineering construction partakes of the nature of an art, not merely of a science. There is no use having contractors deceive themselves into believing that judgment of the man on the job can be eliminated. It can't be done.

Opportunity and Responsibility of Organized Contracting

THE guarantee of $200,000 for its expenses for 1920 and 1921, which the Associated General Contractors of America has secured from its members, as explained in our last issue, carries a greater significance than that the association has a liberal sum for expenditure in organization work. It goes far toward confounding the doubters who a year ago wagged wise heads in assertion that the attempt of contractors to organize nationally had been made before and had failed because contracting was a selfish business and contractors were a jealous class of men who never had learned to co-operate for broader purposes than the monetary object of the moment.

Organized on the broadest plans of mutual co-operation the Associated General Contractors, after a year, finds its members not only voting a schedule of yearly dues which few organizations could hope to impose on their members, but it finds these same members ready to go into their pockets for an additional financial guarantee amounting to an extra tax of $100,000 a year for two years. Truly a little elation is justified the contractors under the circumstances.

Large responsibilities come to the association with large means, and these, apparently, it is entirely willing to accept. The improvement of industrial relations which it plans is a large task. So will be the development of a fair form of contract, the molding of legislation and the correction of insurance evils, to all of which the association has put its hand.

All these are external objectives. It is not enough, however, to gaze only outward. Introspection is also necessary. And looking inward contractors may see required reforms quite as important as those which appear when looking outward. To three of these reforms the association has already decided to address itself: An efficiency classification of contractors; the formulation of a code of ethical practice, and the improvement of the efficiency of contracting work. If the contractors will seriously address themselves to these tasks, they will approach their relationships with engineers and owners in a strong position. Having cleaned their own house they will have a right to demand fair treatment from others—and there is evidence aplenty that with more work than contractors to do it, the constructors are going to demand a mitigation of practices which they believe are unfair.

To these tasks then, the Associated General Contractors can afford to bring their best talent and all the financial support that is needful. Such action, sincere, vigorous, and ultimately successful, is the only means by which there can be secured a wide adoption of a form of contract that takes the gamble out of contracting.

Anchor Pins of Cornwall Cantilever Bridge Bored Out and Renewed

Increased Loading and Twenty Years' Wear Make Renewal Necessary—Pins Freed of Load by Special Connections and Jacking—Hanger Pins of Suspended Span Reinforced by Sleeve Castings

By H. T. Welty
Engineer of Structures, New York Central R.R. Co., New York City

REPAIR work of a unique and precise nature has recently been successfully completed on the St. Lawrence River bridge of the Ottawa and New York Ry. leased by the New York Central R.R. Co.) The work involved the boring out of worn and weak pins and replacing them with new pins of a larger diameter. The work was accomplished without the use of supporting falsework under the bridge and with practically no interruption to traffic.

The bridge was built in 1898. It is of the cantilever type, single track, 841 ft. long between anchorage pins, as shown in Fig. 1 and in diagram in Fig. 4. The channel span is 420 ft.; each anchorage span is 210 ft. 6 in. in length. The design was based on Cooper's E35 loading, but since the bridge was built the traffic over it has increased considerably in both weight and volume. At the present time locomotives producing stresses practically equivalent to Cooper's E42 and trains made up of loaded coal cars weighing 160,000 lb. to 210,000 lb. are permitted to operate.

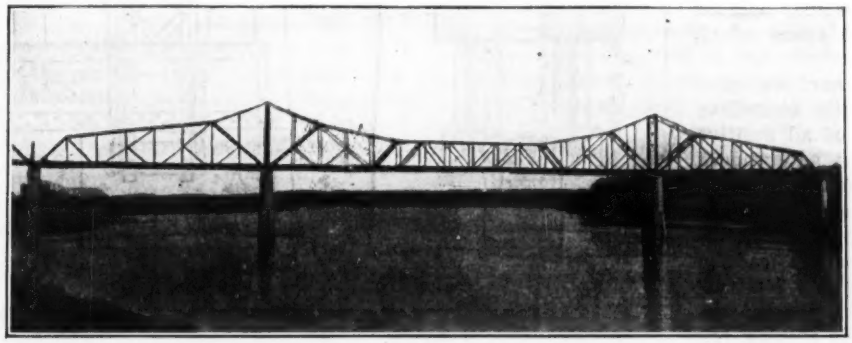


FIG. 1. ST. LAWRENCE RIVER BRIDGE, REPAIRED BY ANCHOR-PIN RENEWAL

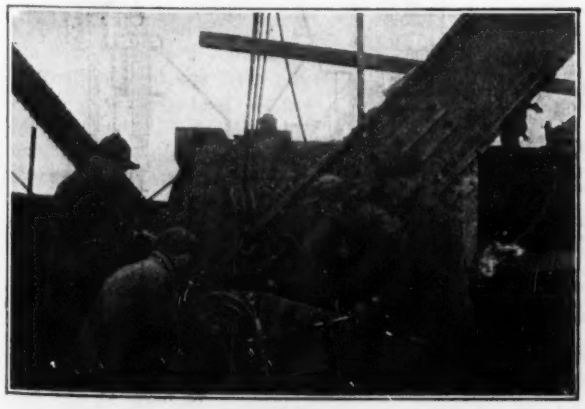
Two factors entered into the necessity for the repair work: (1) wear at the anchorage pins caused by reversal of stress, and (2) high stresses in the pins due to this wear and to the increase in train loads.

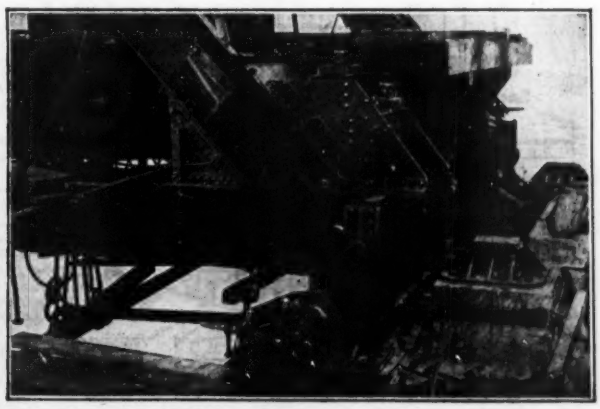
The anchorage at each truss end consists of two channels (see Fig. 4) riveted at the top to the truss shoe and with a pin attachment at the bottom bearing against two transverse girders embedded in the pier masonry. Links to permit longitudinal motion connect the end pins of the trusses with pins through the shoes and anchorage channels.

The work involved four main problems: (1) Design of an auxiliary supporting system strong and rigid enough to retain the bridge members in position under traffic so as to permit a boring tool to cut through these members with absolute accuracy; (2) provision in this supporting system of means for adjusting the bridge members meeting at each pin sufficiently to free the pin from load; (3) so designing the supporting system that while no movement of one bridge member relative to another would take place, the anchor span as a whole could move freely in a horizontal direction; (4) the design of a machine which would bore out the old pins, and would at the same time produce holes for the new pins through all members connected, in perfect alignment.

The supporting system, shown in Fig. 5, may be briefly described as follows:

Jacking brackets were bolted to the top flanges of the bottom chords and the webs of the end posts, against which 25-ton jacks were operated to free the upper pin from pressure of the end post. These may be seen in place in some of the views. Brackets connecting the end post and bottom chord, and serving to





FIGS. 2 AND 3. BORING MACHINE AT WORK ON UPPER AND LOWER END PINS

carry the end-post stress to the upper pin through the bottom chord, were then securely bolted in place. The end brackets of this set were attached to a short cross-girder previously riveted to the end of the bottom chord. Castings bolted to the ends of the cross-girder engaged link bars capable of taking the positive or downward reaction. The link bars were supported through a shoe by a steel grillage anchored to the pier. The bars were designed with pin ends so as to provide for longitudinal movement of the anchor span. Bars were used instead of a stiff riveted member because of the limited space which was available.

The bottom chord was next jacked sufficiently to relieve the upper pin of all positive load, and shims and wedges were driven under the supports of the gross-girder. The lower pin was, of course, relieved from positive load by the same operation. No traffic was permitted over the bridge during the jacking, but as soon as the temporary parts were firmly bolted and wedged in position, train operation was resumed.

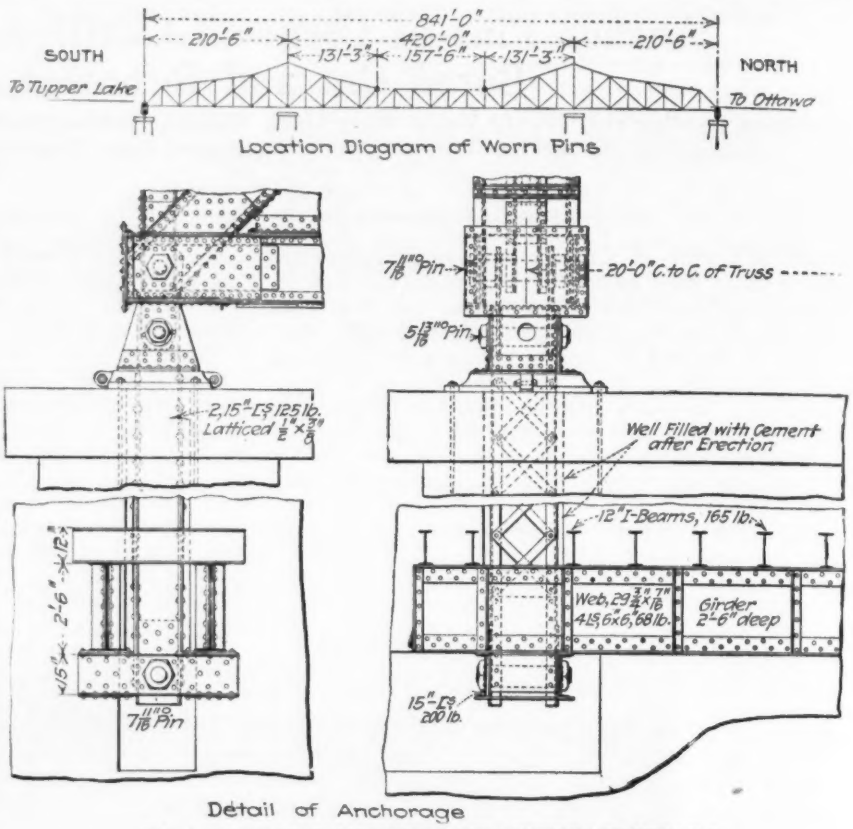


FIG. 4. PIN LOCATION SKETCH AND ANCHORAGE DETAILS

Threaded rods bearing at the top on channel beams riveted between the temporary brackets, and at the bottom on angles riveted to the truss shoe, were provided to take the negative reaction or uplift. These rods also served to clamp saddle castings to the old pins for the purpose of holding them accurately centered during the boring operations (see Fig. 4). In order that the temporary support for positive reaction would not act to take uplift, the upper pin hole in the temporary link bars at the ends of the cross-girder was slightly elongated in the vertical direction. After the pins had been freed from load, trains were permitted to operate for a day or two in order that any yielding of the temporary parts might be corrected. At one or two points some further slight adjustment was necessary, but all pins were finally freed from load, and were maintained in this condition without serious difficulty. The maximum calculated positive reaction at each point is 512,000 lb. and the negative reaction is 270,000 lb.

The boring machine (Fig. 7), which was built at the company's West Albany shop, consisted of a spindle

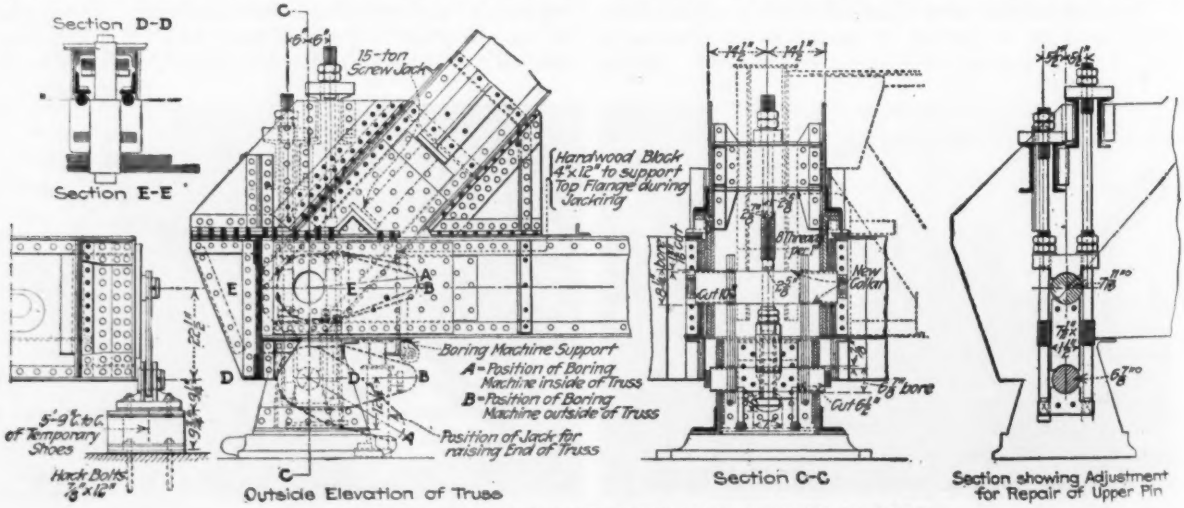

Section D-D
Section E-E
15-ton Screw Jack
Hardwood Block 4"x12" to support Top Flange during Jacking
Boring Machine Support
A = Position of Boring Machine inside of Truss
B = Position of Boring Machine outside of Truss
Position of Jack for raising End of Truss
5'-9" C. to C. of Temporary Shoes
Hook Bolts 7/8" x 12"
Outside Elevation of Truss
Section C-C
Section showing Adjustment for Repair of Upper Pin

FIG. 5. TEMPORARY END CONNECTION TO FREE PINS OF LOAD

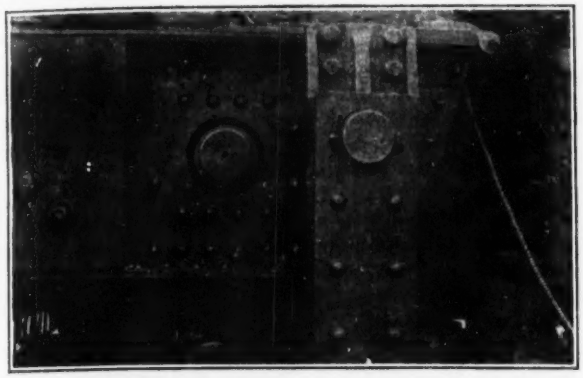


FIG. 6. UPPER PINHOLE BORED OUT AROUND OLD PIN

threaded at the end to screw on the pin to be bored out, a toolhead fitting over the spindle and equipped with cutting tools, and a train of gears operating the toolhead. By screwing the spindle on the pin, the cut was accurately centered. Both automatic and hand feed were provided. An electric motor was first tried as the motive power but was found to be unsatisfactory. A "Thor" air motor, Type N, capable of exerting about 2½ hp., was finally used and proved to be very satisfactory indeed. It was very light and easily handled and could be attached directly to the boring machine, which was impracticable with the electric motor. Thorough tests of the boring-machine equipment were made at the shop before the equipment was sent to the field.

Before the boring machine could be set up on the inside ends of the pins, it was necessary to remove the end floor beams, resting the stringers in the end panels on temporary supports.

The lower pin, $5\frac{13}{16}$ in. in diameter, was bored first. The pin having been freed from load and securely clamped, the anchorage links were wedged to avoid any movement laterally, and after the last train had passed at night, boring was started. The new hole was $6\frac{7}{8}$ in. in diameter, and the distance bored at each end to get through the shoe and link was 6½ in. The average time required to bore each end of a lower pin was about three hours. About two hours' time was required to shift the machine from one end of the pin to the other.

After both ends had been bored the old pin was removed to permit calipering the new hole. It was then replaced and wedged securely in the new hole as a matter of precaution, and the new pin, which was provided somewhat greater in diameter than the finished hole, was taken immediately to a local machine shop and turned to the exact diameter required. This consumed about five hours. The new pin was then immediately inserted.

Practically the same procedure was followed in boring the upper pin hole, which was $7\frac{11}{16}$ in. in diameter and was bored to $8\frac{1}{4}$ in. This point, however, was more difficult to handle due to the fact that the pin passed through six separate members, necessitating boring a distance of 10 in. at each end, and because it was not so readily freed from load. The boring of the upper pins was always done on Saturday nights, as few trains were run on Sundays, thus giving a longer time in which to complete the work without serious traffic interruption.

Two pins were completed each week after boring was started, with the exception of one week taken to transfer the equipment from one end of the bridge to the other end. The bores were extremely accurate and the pins fit the holes in all parts to 0.012 in. In several cases the new pins were turned slightly larger than was intended and a driving fit was obtained.

The introduction of larger pins required the reduction of the net section of the anchorage links. Fortunately, however, there was some excess section in these links, and no reinforcement of them was necessary.

At the time the work was started, the maximum vertical movement due to reversal of reactions under passing trains was about ⅞ in., which was particularly objectionable at the north end, where the adjoining span over the Cornwall Canal is a swing span, equipped with sliding joint bars. After the completion of the work, the vertical movement was not noticeable and is probably less than $\frac{1}{16}$ in.

Guarding Against Interruptions

During the progress of the boring, some delay was occasioned by the formation of ice in the motor. This trouble was overcome by heating the air in the supply pipe and by heating the motor air exhausts with a kerosene torch. Steel shavings jamming between the toolhead and the bore proved another source of trouble. This was not in any way serious, however, except at one point, where it was necessary to replace the machine with another. Fortunately duplicate parts of all mechanical parts subject to breakage or other damage had been provided. The duplicate machines had been built so accurately that the second toolhead entered the hole with an absolutely perfect fit. While every precaution was taken to keep the shavings cleaned out, the space available in which to work was so limited that a thorough job in this respect was impossible.

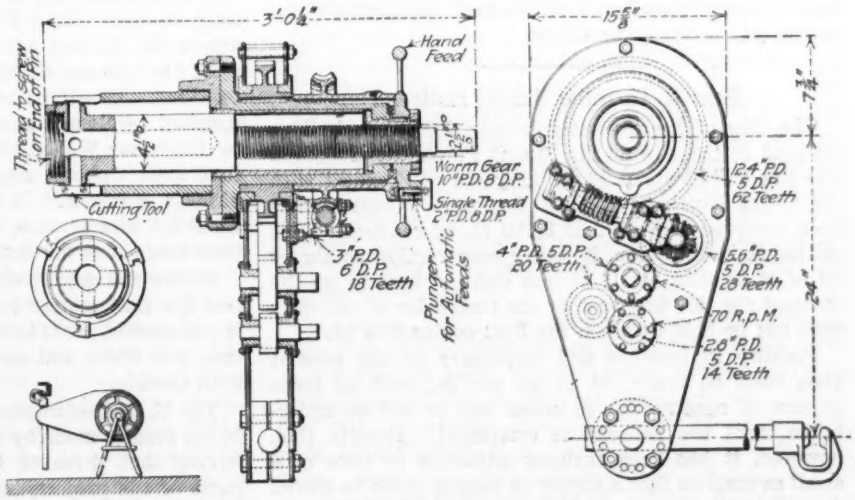


FIG. 7. PIN-BORING MACHINE (SHOWN WITHOUT DRIVING MOTOR)

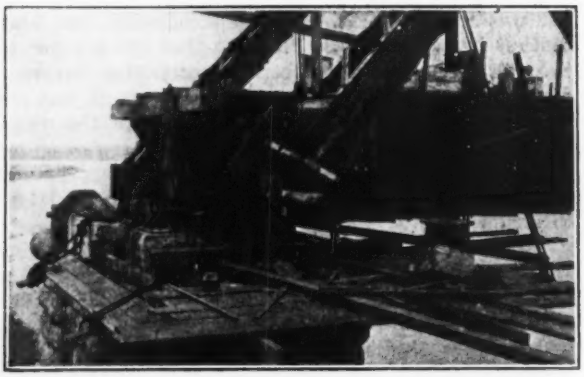


FIG. 8. REMOVING OLD AND DRIVING NEW PIN

The work on each pin was carried on continuously from the time boring operations started until the new pin was driven in place. This entailed severe physical effort on the part of the field engineers as well as the bridgemen, requiring continuous duty of thirty hours or more at times, and frequently in heavy rain storms.

Pin Wear at Ends of Suspended Span

Wear had occurred also in the pins at the ends of the cantilever arms, which support the suspended span, due to cutting from the top lateral struts, as they moved under expansion and contraction. These struts, which consist of two channels, were slotted through their webs, resting directly on the pins. It was impracticable to renew these pins, so cast-steel jackets extending the full length between the top-chord webs were clamped around each pin, and the slots in the lateral struts were enlarged to fit the castings. The castings serve the purpose of strengthening the pins and at the same time will take any further wear which may occur.

The work was planned in the writer's office under the direction of the Engineering Department, New York Central R.R., George W. Kittredge, chief engineer, and J. W. Pfau, engineer of construction. L. R. Manville, assistant engineer in the office of the engineer of structures, had charge of the detailed plans and supervised the operations in the field. W. S. McKinney, inspector, was in immediate charge of the field work, which was carried out by company forces.

Seattle To Build Skagit Railroad

The City of Seattle has definitely decided to build a railroad to the site of the Skagit Power Development. The line will be about 26 mi. long and will connect with the Great Northern R.R. at Rockport. Contract has been awarded for the first 8,000 ft. of roadbed. This section is in exceptionally heavy construction as almost all of it is solid rock. It was thought best to let the contract for this first so that the remainder of the work need not be held up when the final contract is let.

Packing in supplies and machinery at the present time costs so much, 3½ to 4c. per lb., that no large amount of construction is under way or will be undertaken until the railroad is completed. Despite this, however, it has been thought advisable to take in a small sawmill so that a supply of lumber could be stored for use at the site.

Main Features of Columbia Basin Irrigation Project, Washington

A CONCRETE canal carrying 20,000 sec.-ft. of water at a velocity of 12 ft. per sec., concrete-lined twin tunnels each 35 ft. in diameter, quadruple siphons 23 ft. in diameter and impounding and storage dams involving 6,500,000 cu.yd. of material, are main features of the Columbia Basin irrigation project thus far worked out in a preliminary way by the Columbia Basin Commission under the $100,000 appropriation item for surveys made by the Washington Legislature of 1919, according to an address by Prof. O. L. Waller, head of the Department of Civil Engineering of the State College of Washington at Pullman, and secretary of the Commission, delivered in January before the Washington Irrigation Institute. An outline of the project, with the names of the members and engineers of the Commission, appeared in *Engineering News-Record*, Oct. 30-Nov. 6, 1919, p. 800. Of some 3,000,000 acres of land in the basin, it is estimated that 1,700,000 are available for irrigation by gravity.

The project contemplates utilizing the storage of Flathead Lake in western Montana and the natural watercourse from that lake for some 200 mi. to Pend Oreille Lake in northern Idaho. The main-line canal, including tunnels and siphons and the use of natural lakes as watercourses, would have a total of 130 mi. in length and would terminate at Hillcrest in Washington. From this point two canals would extend, one running north of Ralston and Ruff toward Stratford through Adrian and other points, including Quincy; the other running south to Rattlesnake and on to territory south of the Saddle Mountains. The high velocity of 12 ft. per second has been adopted to lessen the amount of excavation and the various difficulties of construction that would be encountered if the ordinary velocities for earth canals were used, taking into account also the fact that at points on the line of the canal there is no good natural ground for supporting canals. Another and important reason for the high velocity is that over long stretches there are no streams large enough to carry the waters of the canal in case it were necessary to empty it. Consequently, storage lakes or waste reservoirs must be provided for the purpose. One of these will be 10.3 mi. long, while two combined will be 16.1 mi. long, besides which Professor Waller mentions three others 2.1, 4.3 and 5.5 mi. in length.

Of the 130 mi. of main-line canal, 53.7 will actually be canal; 40.3 will be lakes (all artificial, except 16.1 mi. supplied by Bonnie and Rock Lakes), and, as described by Professor Waller, there will be 2.1 mi. of "multiple tube steel siphons, each siphon containing four pipes of 23 ft. diameter." It is proposed to construct the main canal full size at once, but to build only one of the two twin tunnels at the outset.

Before the details of the project can be worked out, and for that matter before it becomes certain that it is practicable, state legislation must be secured in Montana and Idaho and an understanding must be reached with Canada.

The U. S. Reclamation Service has been co-operating in the studies made by the Columbia Basin Commission, having sent three or four representatives to go over parts of the project, including D. C. Henny, consulting engineer, Portland, Ore., and James Munn, of Spokane.

Contract Clauses Which Disregard the Square Deal

Service Without Reward Is Demanded If Plans Are Changed or Possession of Plans or Site Is Delayed—Modified Stipulations Suggested

By F. J. Herlihy
Winston Brothers Co., Minneapolis, Minn.

MAJOR requirements which are common to specifications for engineering construction and which are eminently unfair to contractors are: (1) Reservation of the privilege of changing plans without invalidating the prices bid or relieving the contractor from obligation to complete the work; (2) stipulation that instructions by the engineer must be obeyed, that his decision is final and that the progress and sequence of construction shall be as he directs; (3) provision that inconvenience or delay due to any cause shall not entitle the contractor to damages or extra compensation.

Exactly how these stipulations operate unfairly and the size of the penalty which they sometimes impose are facts which are not well understood. To clarify this understanding it is undertaken here (1) to explain the fundamentals of estimating sufficiently to show how the exercise of the privileges enumerated may invalidate an estimate; (2) to illustrate by actual example how changes in plans have changed the cost of construction; (3) to indicate in what manner these stipulations may be modified so as to eliminate their vicious character without injury to any of the interests concerned.

Fundamentals of Cost Estimates

As a hypothetical example an ordinary unit-price contract is assumed. The payment quantities consist of only the major items of work, such as earth and rock excavation and concrete masonry. A simple unit price is asked per cubic yard for each of these items, and this price includes all expenses incurred either directly or indirectly in the execution of the work.

To determine the method of attack and the size and kind of plant and organization required it is necessary to know: The volumes of the different classes of work; the balance between the expensive and inexpensive items; the availability of materials; the climatic conditions; the time allowed to perform the work; the date of effective possession of the site; the promptness with which plans and instructions may be expected; the wages and the supply of labor; the possibilities of contracting for materials ahead of construction; the volume of non-revenue-producing work which must be pro-rated against the revenue-producing items, and the sequence of construction.

Brief consideration discloses why this information is necessary and should be, as far as is possible, accurate and definitive. Construction to be performed economically must be begun at the proper point and proceed connectedly to a fixed objective. False moves are expensive. All operations must be concurrent and in logical sequence. Plant and organization must always be the minimum consistent with economical production and with the completion of the construction on time. They have to be planned so that they are available as needed for the different classes of work, and so balanced that the individual classes are prosecuted in such order that as much of the whole work as is practicable may be executed at the same time, and that all equipment and men are kept busy from the time they are placed at work until they are finally laid off.

Analysis of Expenses.—Construction costs are general or indirect and specific or direct. Indirect expenses, which must be pro-rated against the revenue-producing items, subdivide into overhead, installation and dismantling, and miscellaneous work. Direct expenses, which can be charged against the revenue-producing items, include plant rental, permanent materials and operating expenses.

It is important to have clearly in mind the nature of indirect expenses. Overhead charges are interest on the investment, liability insurance, superintendence, hire of clerks and watchmen, field and general office expenses, railway fares and incidentals. Installation and dismantling charges are all expenses incidental to installing plant and construction facilities in working condition and the dismantling and storing or shipping of this equipment when the work is completed. Miscellaneous charges include drainage, maintenance of public utilities and other expenses not chargeable to definite items.

Observe that all of the charges which made up indirect expenses are either fixed quantities or their amounts depend upon time. Any changes in the payment quantities of the various classes of work on which these charges are based, will affect their unit cost to the work and consequently produce conditions different from those anticipated at the outset and make the value of the contract work different from that intended by the original agreement.

Plant rental and operating expenses are particularly affected by change of plans, delays, etc. Whether rental charges are made directly against individual classes of work or are pro-rated, it is obvious that they will be a fixed quantity per day and any variation in the daily output will affect the unit plant rental charge to the work. If the work is delayed for any reason and the plant stands idle the daily costs will accrue and no extension of time nor any other concession, except to pay the contractor at the rental value for the equipment, will compensate him for the loss.

Operating expenses include all charges for labor and material, and supplies (explosives, fuel, etc.) and the freight charges thereon, incurred in excavating rock and earth and in constructing concrete masonry. The bulk of this expense, except explosives, will be a fixed quantity per unit of time. Therefore, any change in the periodical output of work will affect the unit charges against the work.

As average unit prices are asked for earth and rock excavation and concrete masonry, the price bid is based on the average value between the expensive and inexpensive elements of the different classes of work. Should the balance between this profitable and unprofitable work be disturbed, it is bound to affect this average value. In case the work is delayed the cost will not only be increased by the expense of holding the necessary

nucleus of an organization under pay, but it will be still further increased by the reduced efficiency of a new organization, which will require some time to train. Should the sequence of the work be changed and the work prosecuted piecemeal instead of in economical sequence, both the plant rental and the operating charges will be affected, as false moves of plant and organization will then be necessary, and they are expensive.

Permanent material charges should not vary unless the work is so delayed that material dealers withdraw their protected prices, or unless the sequence of the work is such as to make the requirements spasmodic and beyond storage facilities or the output of the dealers who have contracted to fill the requirements, and force the contractor into the open market to procure the extra material required to keep going.

Example of Altered Costs

Changes which can be brought about in the cost of construction by changing plans are clearly indicated by an actual occurrence in the writer's experience. The work was the widening of a canal. It called for the removal of a strip on each side by steam shovels and the excavation of a trench by hand in the remaining ledge for the foundation of a concrete wall. Average unit prices were called for, a single price per cubic yard being bid for rock work. The engineer, after altering the characteristics of the work to the extent indicated in Table I, ruled that the contractor must perform the work at the prices bid originally. The work was performed under protest and a claim for extra pay was submitted to arbitration. The decision was against the contractor.

By reference to Table I it will be seen that the engineer changed the character of the work by decreasing the inexpensive quantities and increasing the expensive quantities.

In the stipulation defining changes in plans the wording should be so amended that, while it still gives the proprietor, or his engineer, the right to make any changes he sees fit, if by the changes the characteristics of the work or the conditions governing its execution are changed to the extent of changing the value of the work, provision is made to change the contract price accordingly.

Provision should also be made in this stipulation to protect both parties when changes are made in the unit quantities. This can be done by bidding a lump sum for the work, based on the unit quantities scheduled in the call for bids, which quantities should be guaranteed by the proprietor and stating also a unit price for each item, this unit price to be used only in adding to or deducting from the lump sum bid, when changes in the quantities are made. In making up his bid under this arrangement, the contractor can make his lump sum to cover all costs and profits, including overhead and indirect charges based on the guaranteed quantities scheduled, and he will include in his unit prices only such charges and profits as are directly affected by the direct expenses. In this way the contractor will be sure of his general expenses and profits on the work actually done, no matter how much the quantities are reduced, and the proprietor will benefit, in case quantities are increased, by paying only the cost and profit for the extra work done. It is, of course, understood that this arrangement would only apply insofar as increases in quantities are concerned when the increase would not entail the bringing on of extra equipment to do the extra work, but that the increased work can be done with the equipment already on hand, by granting an extension of time or working extra time, such as double shift, or otherwise.

In contracts where unit prices only are stated, either one party or the other must suffer when quantities are changed. When the quantities on which the bids are based are reduced, the contractor will suffer to the extent of the overhead and other indirect expenses which he has charged against the work that has been eliminated, and if the payment quantities are increased, the proprietor will lose by having to pay for the increase at the same unit price as for the original contemplated quantities, against which latter the entire overhead and other indirect expenses are charged. As to the proprietor guaranteeing quantities, this is as it should be. This burden should not be placed upon the contractor, who has neither the time nor anything like the facilities which the engineer has for ascertaining this element of the contract.

The stipulation making the signed order of the engineer acknowledging claims for extra work a condition precedent to the contractor's making claim or receiving compensation for extra work should be stricken from all contracts because it is manifestly unjust.

This stipulation clothes the engineer with autocratic authority, which he does not need to maintain the rights of either party, and which can only be useful to an official who wishes to invade the rights of the other party and impose upon him conditions that were not intended by the original agreement. If the engineer assumes a position on any matter that is consistent with the in-

TABLE I. COMPARISON BETWEEN COST ESTIMATED ON ORIGINAL QUANTITIES AND ACTUAL COSTS INCURRED BY CHANGED QUANTITIES

A—According to contract and specifications:		
Machine work, 430,380 cu.yd. at $0.611		$262,962.18
Hand work, 5,800 cu.yd. at $3.611		20,943.80
Total		$283,905.98
Cost per cu.yd., $283,905.98 ÷ 436,180		.651
B—Cost of work actually done under altered conditions on above basis:		
Ordinary machine work, 268,168 cu.yd. at $0.611		$163,850.65
Expensive deepening, 13,200 cu.yd. at $1.469	$19,390.80	
Hand work—ledge excavation, 34,500 cu.yd. at $3.611	124,579.50	
Hand work—foundation excavation, 5,832 cu.yd. at $3.611	21,059.35	
Hand work—miscellaneous excavation, 709 cu.yd. at $3.611	2,560.20	
		167,589.85
Total		$331,440.50
Cost per cu.yd. $331,440.50 ÷ 322,409		1.028
Cost per cu.yd. as per contract		.651
Balance or loss per cu.yd.		$0.377
Total loss to contractor = 322,409 × $0.377		$121,548.19

tent of the contract, his interpretation will prevail without the aid of this stipulation, but if his position is not consistent with the original agreement, he should be overruled.

The engineer should have the power to order performed any work that is necessary and the proprietor should be protected against imposition by having these orders written, but if that work is extra work, not contemplated under the true interpretation of the contract, the proprietor should pay for it. The engineer should also be master of the situation insofar as the interest of the work is concerned, but all differences of opinion as to the interpretation of the contract, regarding claims which either party may have which have not been adjusted at the time, should be submitted to arbitration at the close of the enterprise. There should be a stipulation in every contract whereby either party will have the right to have its differences arbitrated at the conclusion of the contract, and neither party to the contract should be its final arbiter.

A stipulation which gives the engineer the power to direct the sequence of the work should be eliminated from all contracts, except those in which the required sequence is clearly disclosed by the information given to the bidder at the outset.

Any change in the sequence of the work is bound to affect its value adversely to the contractor, as he will have chosen the most economical sequence in organizing the work. If the engineer has some particular sequence in mind, there is no reason why this information should not be disclosed beforehand, unless it is that he is uncertain of his ability to deliver the site, plans, etc., on time, in which case the risk should be with the one who controls the situation and not with the contractor.

The stipulation headed "inconvenience or delay" should be amended to place the whole responsibility for delays on the party who causes them.

The contractor should not be made to suffer the monetary loss incurred in holding plant and organization idle through the fault of the proprietor. He does more than his fair share when he assumes the monetary loss due to delays caused by climatic conditions, actions of the elements, labor and material troubles, and his own errors of judgment. As before stated, neither an extension of time nor any concession, except monetary compensation, will compensate the contractor for delays.

Public Water Supplies the Rule in Massachusetts

Cities and towns in Massachusetts provided with public water supplies numbered 214 at the close of the year 1919 and had a total population of 3,528,139 in 1915. The 140 towns without public water supplies had a combined population of only 165,171 at the same date. Under the Massachusetts classification of the minor several divisions of the State, cities and towns together comprise the entire area of the State. Of the 140 towns in the State without public water supplies, there were at the close of 1919 only 21 which in the year 1915 had a population in excess of 2,000. The largest of these was Tewksbury, with a population of 5,265. The 21 towns with populations in excess of 2,000 which still lack public water supplies had a combined population in 1915 of 59,162. The foregoing figures are taken from the annual report on the "Care of Inland Waters" made to the Massachusetts Legislature by the State Department of Health.

Designing Concrete Columns With Cast-Iron Core

Diagram May Be Used for Hooped Columns With Cast-Iron Cores or With Only Steel Vertical Reinforcement

By W. H. Roney, Jr.
Structural Engineer, St. Charles, Ill.

In reconstructing old buildings it frequently becomes necessary to strengthen cast-iron columns which are so located as to make their removal difficult. The most satisfactory way to do this is to incase them in concrete, adding such reinforcement in the form of steel hooping as will bring them up to the required strength. The diagram given herewith has been devised for the purpose of such design, but it can also be used for the design of reinforced-concrete hooped columns in which there is no cast-iron core but which have vertical steel.

The diagram is based on the Chicago building code, from which may be deduced the following equations, pursuing the same general line of computation followed by J. Norman Jensen in the article "Concrete Column Economics," *Engineering News*, June 6, 1912, p. 1070: Let

f = Average allowable unit compressive stress on concrete.
f_c = Allowable unit stress on concrete.
f'_s = Allowable unit compressive stress on steel.
f''_s = Allowable unit compressive stress on cast iron.
E_s = Modulus of elasticity of steel.
E_{ci} = Modulus of elasticity of cast iron.
E_c = Modulus of elasticity of concrete.

$$n = \frac{E_s}{E_c} \qquad n' = \frac{E_{ci}}{E_c}$$

P = Load.
A = Effective cross-sectional area out to out of hooping.
A_c = Area of concrete.
A_s = Area of vertical steel.
A'_s = Area of cast iron used as vertical reinforcement.
A_h = Area of hooping steel.

$$p = A_s \div A \qquad p' = A_h \div A \qquad p'' = A'_s \div A.$$

For reinforced-concrete hooped columns with both steel and cast-iron vertical reinforcement.

$$f = f_c[1 + 2.5\,np'][(1 - p') + (n - 1)p + (n' - 1)p''] \ldots\ldots\ldots\ldots\ldots\ldots (1)$$

For reinforced-concrete hooped columns with cast-iron vertical reinforcement only.

$$f = f_c[1 + 2.5\,np'][(1 - p') + (n' - 1)p''] \ldots (2)$$

For reinforced-concrete hooped columns with steel vertical reinforcement only. (The original equation deduced by J. Norman Jensen in the foregoing named article.)

$$f = f_c[1 + 2.5\,np'][(1 - p') + (n - 1)p] \ldots (3)$$

E_{ci} = 12,000,000 to 14,000,000 (Marks, "Mechanical Engineers' Hand Book").

E_s = 30,000,000 and E_c = 2,000,000 for 1:2:4 concrete,

therefore

n' = 6 to 7 and n = 15 for 1:2:4 concrete.

Eq. (2) may meet with the objection that it does not meet with the requirements of the code, providing for reinforcement on the outer perimeter of the column

reinforcement, and further that cast iron has not the tensile resisting qualities of steel, but on the other hand may throw some light on the tests of reinforced hooped columns using only cast iron for vertical reinforcement, the tests of which have seemed to indicate that these columns have a strength less than that of the concrete considered as a column alone, plus the strength of the cast iron as a column. Since Eq. (2) is based upon the theory that the stresses in the concrete and vertical cast-iron reinforcement are proportionate to their respective moduli of elasticity, this formula is likely to give consistent results for this class of columns.

The chart accompanying this article will give values for the average stress in pounds per square inch (f) for either Eq. (1), (2) or (3), and may be used either to design by or to check with. A few illustrative examples will be given as follows:

Example 1—Find the average allowable stress f for a concrete column in which $p'' = 3$ per cent, $p = 4$ per cent and $p' = 1$ per cent.

Enter diagram at right-hand side on vertical line 3 per cent for p'', follow down to its intersection with diagonal line 4 per cent for p, next follow horizontal line, passing through this intersection, toward left-hand side of diagram to intersection with vertical line 1 per cent for p'; the answer is found on diagonal line passing through this intersection, to be $f = 1{,}170$ lb. per square inch.

Example 2—Find the average allowable stress f for concrete column in which $p'' = 5$ per cent, $p = 0$, $p' = \frac{3}{4}$ per cent.

In similar manner follow vertical line for $p'' = 5$ per cent down to diagonal line for $p = 0$, thence to left on horizontal line to vertical line for $p' = \frac{3}{4}$ per cent; read answer $f = 820$ lb. per square inch on diagonal line.

Example 3—Find average allowable unit stress f for concrete column in which $p'' = 0$, $p = 3$ per cent and $p' = 1\frac{1}{4}$ per cent.

Enter diagram at right-hand side on vertical line $p'' = 0$, follow down to intersection with diagonal line for $p = 3$ per cent, thence to right on horizontal line to intersection with vertical line for $p' = 1\frac{1}{4}$ per cent, and find answer $f = 1{,}020$ lb. per square inch on diagonal line.

Example 4—Find vertical steel percentage p to be used in a concrete column in which $f = 1{,}100$ lb. per square inch, $p' = 1$ per cent and $p'' = 5$ per cent.

Enter diagonal line on left-hand side for $f = 1{,}100$ lb. per square inch, find intersection with vertical line for $p' = 1$ per cent, thence follow horizontal line toward right to intersection with vertical line for $p'' = 5$ per cent, and read answer on intersecting diagonal line for $p = 2.4$ per cent.

Example 5—Find percentage of spiral hooping p' required for a concrete column in which $f = 1{,}300$ lb.

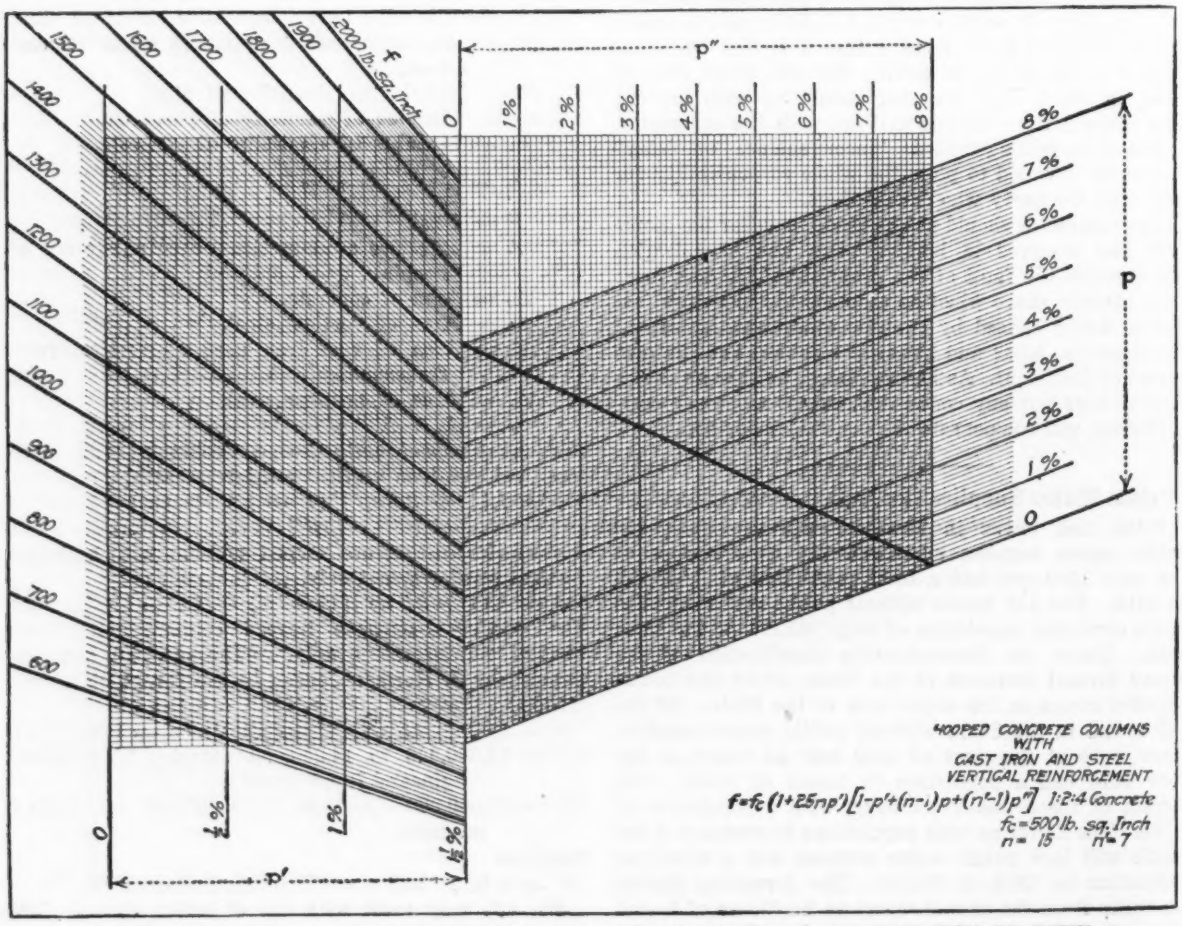


CHART FOR DESIGNING HOOPED REINFORCED-CONCRETE COLUMNS WITH CAST-IRON OR STEEL VERTICAL REINFORCEMENT

per square inch, $p = 4\frac{1}{2}$ per cent and $p'' = 3$ per cent.

Enter diagram on right-hand side for $p'' = 3$ per cent; find intersection with diagonal line $p = 4\frac{1}{2}$ per cent; follow horizontal intersecting line toward right to intersection with diagonal line for $f = 1{,}300$ lb. per square inch. Answer is found on vertical line passing through intersection for $p' = 1.25$ per cent.

The above examples are all for 1:2:4 concrete and $n = 15$, $n' = 7$. They are enough to demonstrate the workings of the chart and to show that the allowable stress in pounds per square inch may be readily and quickly found where the percentages of vertical and spiral reinforcement are known or assumed or vice versa.

Note, however, that if values of vertical steel are used below the diagonal line passing through intersection points of $p'' = 8$ per cent, $p = 0$ and $p = 8$ per cent, $p'' = 0$, the total amount of vertical reinforcement will not exceed 8 per cent, also if values of p' are used between limits of $\frac{1}{2}$ per cent and $1\frac{1}{4}$ per cent, both inclusive, the ordinance is complied with in this respect.

Large Combined Outlet Sewer

LARGE area, scattered populaton and flood conditions were factors in the design of a 7-mi. concrete outlet sewer and storm-water conduit now being built at Granite City, Ill. The high relation of area to population is due to the holding of vacant tracts as investment or for industrial sites.

An 18-mi. combined sewerage system has its main sewers discharging into an open ditch leading to the levee, where a pumping station handles the flow during high water. The normal dry-weather sewage flow is about 1,300,000 gal. per 24 hr. and the new 7-mi. outlet sewer is designed to take care of a rainfall of 2 in. per hour. This sewer, serving a drainage area of 6 sq.mi., will provide more rapid removal of flood water besides keeping the ground-water level at a minimum and eliminating the present open ditch. Intercepters will connect the laterals with the main outlet sewer. The latter has a grade of 0.10 per cent to 0.06 per cent and is of circular section, 9 ft. to $4\frac{1}{2}$ ft. in diameter, but the exterior has a flat base with vertical sides to the springing line. The thickness is $8\frac{1}{2}$ to 11 in. for the arch and 10 to $12\frac{1}{2}$ in. for the invert.

During high water the flow will be raised 6 ft. by pumps and discharged into a 6-ft. culvert through the levee, this being closed automatically by a flap valve when the river rises above it. The pumping station has been in use for 17 years, handling the flow from the present open ditch. Its sump has been lowered about 5 ft., however, to the grade of the new outfall sewer and the discharge culvert raised 1 ft. to conform to the new flood-protection level. Three centrifugal pumps, each having an electric motor in its vertical shaft, have a combined capactiy of 12,700 gals. per minute.

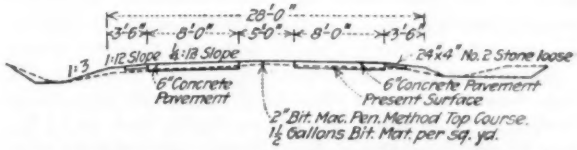
Plans were made in 1913 by Edmund Hall, city engineer, but as the entire city will be benefited, the assessments and court proceedings occupied so much time that the contract was not let until 1916. The cost was estimated then at $450,000, but changed conditions have raised this to $650,000, necessitating supplemental assessments. Work was stopped for about a year by war conditions and by efforts to compel the use of none but union labor. The John T. Walbridge Engineering Co., Chicago, has the contract. Edmund Hall and W. W. Kerch are the engineers for the city.

Utilizing Old Macadam To Increase Width of Concrete Road

Sixteen-Foot Surfacing Built in Two Strips With Bituminous Surface Between—Traffic Maintained—Labor Cost

RECONSTRUCTION of old macadam roads by building a concrete surface in two strips with the old surface left in the middle, has been resorted to in Division No. 7, New York State Highway Department. After the concrete has been constructed the macadam receives a bituminous surface. By this design, the old surfacing is utilized for foundation where it is good, an extra-wide road is obtained, and it is easy to keep roads, where there are no good detours, open to traffic during construction. While such construction is considerably more expensive than building in one piece, it is thought the benefits outweigh the extra expense. It is also believed that longitudinal cracking of the concrete will be eliminated.

New York State, like many other states, has a large mileage of macadam roads which have partially broken down under the heavy traffic of recent years, a traffic which they were never designed to carry. This failure has been chiefly along the edges, the central part being in fairly good condition. Designs are therefore being considered which will utilize the previous investment



TYPICAL SECTION OF TWO-STRIP CONCRETE ROADS WITH BITUMINOUS CENTER

to the greatest extent possible. In some cases the old macadam is being used as a foundation for other surfacings, while in others an endeavor is being made to retain all or a part of the old work by giving it a new top or thin surface treatment in the center, with concrete strips on either side. This type of construction as used on Maryland roads was described in *Engineering News-Record* of Nov. 28, 1918, p. 990.

On repair contract No. 1206, Division No. 7 of the New York State Highway Department, which is between Geneseo and Mount Morris in Livingston County, this latter type of construction is being used. The section of road selected for trying it out is about one mile long and extends across a low flood plain of the Genesee River. Once or twice a year the road is covered with water to varying depths, and in one case, recently, it was deeply covered with ice, necessitating the chopping of a road through to accommodate traffic.

The nature of the country and the scarcity of roads made it not feasible to construct a side road or provide detours. Furthermore, it was necessary to keep the road open for traffic, as it is the main route between Rochester, Geneseo, Mount Morris, Danville and the southern part of the state. As the road had a fairly good macadam surface, it was decided to build of concrete and in two strips 8 ft. wide, with the central portion as mentioned above. The cross-section design is shown in an illustration. The center is 5 ft. wide and the concrete is built about 3 in. higher than the old surface, to provide for the addition of a penetration

ARRANGEMENT OF PLANT SHOWING CONGESTION DUE TO PILED MATERIAL

bituminous top. A 2-ft stone shoulder will be built on each side, making a surface 25 ft. wide.

The concrete strips are uniformly 6 in. thick and are constructed with a uniform slope from the inner to the outer edge. Premolded bituminous expansion joints were used every 30 ft. and are submerged 2 in. However, full-depth joints were used at points of stoppage and at the end of every day's run. Niagara River grit and Niagara limestone were used for the aggregates. This limestone is of a hard, flinty variety. The proportions specified were 1:1½:3, the coarse aggregate being graded so as to contain 30 per cent three-inch, 50 per cent two-inch and 20 per cent one-inch stone.

Regarding the 2-in. submerged expansion joints, the department engineers state that these are just as effective as those which are of less depth, such as 1½ in., and do not have the disadvantages. In finishing over the joints submerged only ½ in., it is hard to get a smooth surface on account of irregularities in placing the joint. Also, the concrete on each side of the shallow, submerged joint tends to break off in large, flat spall. This does not occur with the deep joints. While the line of cracking is sometimes not as regular as with the shallow depth, it occurs directly over the expansion, and no spalling occurs. No reinforcement was used in the slabs.

Construction

Grading—Inasmuch as the road had been improved with macadam and had an established grade, the macadam excavation quantities were comparatively light. As the concrete was placed 3 in. above the old surface and the macadam had a larger crown than the new construction, there was a maximum cut of about 3 in. at the inner edge, which decreased toward the outer edge. Added to this was the excavation necessary to form new ditches and shoulders, made necessary because of the additional width of road.

Work proceeded on one strip at a time, thus leaving the other half of the road open for traffic. The grading gang started at one end and graded one side, then returned to the same end and graded the other side. This procedure not only allowed the mixer always to work toward the source of materials, but also allowed for a cross-over of traffic from the concrete to the old macadam near the end which was finished first, while at the place of beginning the concrete had hardened enough to allow traffic, by the time the excavation of the other side started.

The old surface was first scarified in the usual manner, and the excess material was thrown over to the side for the purpose of widening the shoulder. It was aimed to use as much of this stone as possible in widening out the remaining stone base of the old macadam, so as to give a uniform foundation for the concrete surface. What was not required for this purpose was used upon the shoulder. At the same time, where a well defined shallow ditch line existed, the back slopes were graded out to form the new drainage, and the material was passed inward to widen the shoulders. After fine grading, the subgrade was thoroughly compacted with a 10-ton roller. The excavated material was not found sufficient to construct the shoulders properly, and it was necessary to use considerable borrow. It is of course impossible on such reconstruction where no readjustment of the grade is practicable to balance the excavation quantities.

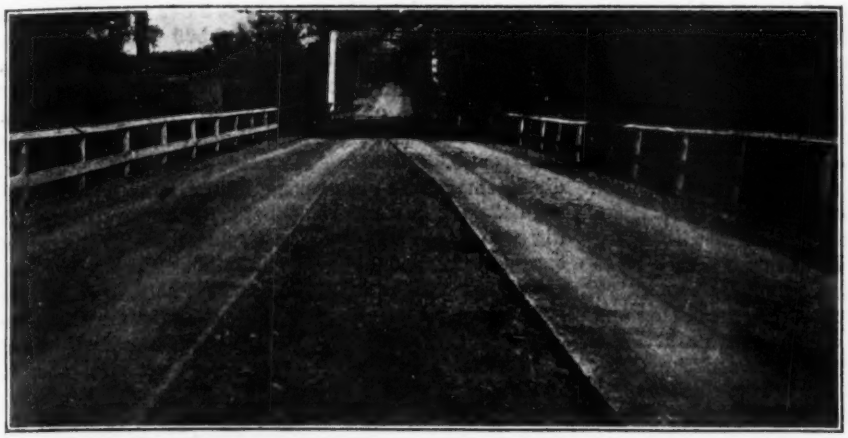
Delivery of Material

Material was delivered by both motor trucks and teams and was deposited on the subgrade and central strip. The plan was to use the central strip for storing the crushed stone, and the outside of the subgrade and a portion of the shoulder for storing sand, leaving a space between to operate a mixer loader. In delivering the stone the contractor attempted to store sufficient coarse aggregate to build both strips of concrete. This, according to the engineer in charge, was a great mistake, as the 5-ft. strip was not wide enough for the purpose and considerable rehandling of material was necessary when grading the second strip. It was also hard to keep this extra stone clean. It is believed that the cost of manipulation would not have been so high if all the material for each strip had been delivered separately, as in the case of the fine aggregate. No cost data are available for the hauling and, according to the engineers, would be of little value on account of delays due to strikes and other causes.

ITEMIZED COST OF MANIPULATION IN BUILDING CONCRETE ROAD SLAB FOR TWO-STRIP CONSTRUCTION

9 shovelers at $3.60 per day (six on stone and three on sand)	$32.40
1 man on cement at $3.60	3.60
1 man on grading at $3.60	3.60
2 men spreading concrete at $3.60	7.20
2 finishers at $3.60	7.20
3 form builders at $3.60	10.80
1 mixer man at $4.00	4.00
1 fireman at $4.00	4.00
1 foreman at $5.00	5.00
Total cost per day	$77.80

The forms for the concrete were of wood. It will be noted that the form work is double that needed for single-type road, which is responsible for some of the higher cost of this type of construction. The plant used by the contractor for the construction of the concrete slabs consisted of a mixer, used in connection with a loader, as stated above, and as shown in an



CONCRETE COMPLETED, SHOWING METHOD OF NARROWING AT BRIDGE

illustration. The loader ran between the two piles of material, the men shoveling in from each side. The cement was also stored on the central strip and the congested conditions may be noted. The gang used for the operation of this outfit was as shown in the accompanying table. The men worked an eight-hour day, and common labor was paid 45c. per hour, or $3.60 per day. The usual arrangement of men before and behind the mixer was used.

This gang, with good running, turned out about 550 ft. of 8-ft. strip per day, 81.5 cu.yd. This gave a manipulation cost of about 95c. per cubic yard. To this should be added depreciation, superintendence and interest on the plant investment. The cost of excavation, covering, protecting the finished concrete, etc., was not available but is thought to be somewhat higher than in ordinary highway grading, on account of the narrow limits in which the work had to be done. The cost of the concrete slab was also more or less affected by extra travel of the mixer and the congestion caused by the delivery of all the stone at one time.

Placing the Five-foot Bituminous Center Strips

Upon completion of the two concrete strips, the shoulders were graded, the crushed stone edgings were added, and the penetration top was put over the old macadam center. The subgrade in the strip was first shaped and then rolled with a five-ton tandem roller. This was the only rolling that could be given, as the strip was not wide enough to permit the use of a 10-ton roller. After the stone was spread, two applications of bituminous material were given, one of 1.2 gal, and a second of $\frac{3}{10}$ gal. per square yard. The material was applied under a subcontract, at the rate of 5c. per gallon or 7½c. per square yard. Final compression was given by a 10-ton roller. This did not include the heating of the filler, which was done by the contractor. A view shows the two strips at the approach to a bridge ready for the laying of the central strip. Note the method of narrowing down to join the bridge floor.

Criticism of Two-Strip Type of Construction

Two-strip construction is stated by the engineer in charge to be more expensive than one-strip construction. It is believed that the central strip should be made more than 5 ft. wide, so as to be wider than the gage of ordinary vehicles. Not less than six, and probably eight feet is suggested as advisable by the engineers. It is probable that difficulty may be experienced in maintaining the edges of the central portion next to the concrete, as the transition from an extremely hard surface to a more pliable one will tend to make an uneven joint. It is expected that in the near future this center strip will be replaced by concrete, which on account of the type can be built without much inconvenience to traffic.

The work was done under the supervision of Charles M. Edwards, division engineer, New York State Highway Department. M. S. Smith was assistant engineer in charge, and the contractor was the R. W. S. Corporation of Syracuse, N. Y.

What Is the Present Status of the Concrete Ship?

Concrete Institute Committee Report Gives Résumé of Current Export Opinion on Type of Vessel Developed by War

Abstract of report read at convention of the American Concrete Institute at Chicago, Feb. 16-18, 1920, by H. C. Turner, chairman of the Committee on Reinforced Concrete Barges and Ships.

THE original concrete-ship program of the Emergency Fleet Corporation called for the construction of thirty-eight 7,500-ton vessels, three 3,500-ton vessels and one 3,000-ton vessel, making a total of 42 vessels. Immediately after the armistice, this program was reduced to eight 7,500-ton tankers, two 7,500-ton cargo vessels, three 3,500-ton cargo vessels and one 3,000-ton cargo vessel, or a total of 14 vessels. In October 1919, the two 7,500 ton cargo vessels were cancelled, leaving twelve vessels to be completed.

At this date, all of the four small cargo vessels are in service. They are the "Atlantus," 3,000 tons dead weight, and the "Polias," "Cape Fear" and "Sapona," each of 3,500 tons dead weight. [The "Polias" went ashore near Penobscot Bay, Maine, on Feb. 6, 1920. See article on p. 483 of this issue.—EDITOR.] Of the 7,500 ton tankers, three have been launched, the "Palo Alto" at San Francisco and the "Selma" and "Latham" at Mobile. The remaining five tankers are in various stages of completion. It is expected that all will be launched before April 1 and all will be in commission before June 1.

In addition to these vessels, twenty-one 500-ton canal barges were built by the Railroad Administration under the supervision of the Emergency Fleet Corporation. All of these barges are in service with the exception of one which was sunk in the Hudson river in the early part of December.

In general, it may be said that in carrying out the concrete ship program, no construction problems have been encountered that have not been successfully met. The original design of the 7,500-ton tankers has been modified to some extent, owing to the discovery of un-

desirable high stresses in some of the members under test and service conditions. While the revisions contemplated involved concrete construction seldom, if ever before, attempted, it is believed that the changes will remedy the undesirable conditions. The experience of the vessels in service thus far indicates that, so far as the cargo vessels are concerned, there is ample structural strength, and the barge is a much simpler problem.

The hope that reinforced concrete would provide a material from which hulls could be built with much greater speed than is possible in the case of steel has not been realized. The average time of constructing the concrete hull has been seven months. Outfitting and equipping the hull has taken on an average between three and four months. Undoubtedly with the experience gained, this time could be materially bettered.

The experience with the ships in service thus far indicates that they are good sea boats. In every case of which there is record, these ships have behaved admirably in heavy weather and have won considerable praise from officers and crews. There is generally very much less vibration in concrete ships than in corresponding steel ships. There is also a very considerable increase in the period of roll, which is quite desirable. The increase in the period of roll is undoubtedly due to the fact that these vessels have a relatively large moment of inertia around a longitudinal axis even when loaded with cargo. This is due to the mass of the concrete shell which is considerably greater than the mass of the shell in a steel ship. In none of the vessels in service has any leakage whatever been reported. A few shear cracks are noticeable in the shell and bulkheads in all the ships in service, but these cracks are unimportant and have no apparent effect upon the structural strength of the ship.

One characteristic of the concrete vessels built by the Emergency Fleet Corporation should be noted in this connection. Experience seems to indicate that these vessels are unable to successfully withstand severe concentrated blows on the shell without the shattering of the concrete. Impact which, in the case of the steel ship, would probably only cause indentation to the plates, in the case of the concrete ship is apt to cause a shattering of the concrete over the area adjacent to the point of impact. A number of instances of injury of this kind have been observed, particularly in the case of the barges constructed for the Railroad Administration. In the case of nearly every barge the shell has been injured in one way or another requiring repairs to the concrete. It has been found, however, that repairs are relatively simple and can be effected with little loss of time and at almost negligible cost. The barges in question have very little protection in the form of fenders. It is believed that where adequate fenders are provided, so that there is chance for the absorption of the work of a blow by means of some resilient material, such as an oak fender, this objectionable feature of the concrete barge may be obviated.

The figures noted above for the dead weight capacity of the several ships constructed by the Emergency Fleet Corporation are the nominal dead weight capacities contemplated by the design. In no case has the nominal dead capacity of the ship been realized. The average dead weight capacity of the 7500-ton tankers will be in the neighborhood of 6,800 tons. In the case of the "Atlantus," nominally having a capacity of 3,000 tons, the actual dead weight capacity is 2,542 tons; the "Cape Fear" and "Sapona" nominally 3,500 tons, have dead-weight capacities of 3,078 tons; the "Polias," nominally 3,500 tons, built of heavy gravel concrete, has a dead weight capacity of 2,460 tons. It was expected that the ratio of dead-weight capacity to displacement would run from 0.55 to 0.60. The actual ratio of dead-weight displacement will not average but little more than 0.50.

In making a comparison between the relative carrying capacities of steel and concrete ships, one important consideration should be kept in mind. Taking into consideration a steel ship and concrete ship, each having the same dead weight capacities, the concrete ship—because of the greater weight of the ship itself—must have greater dimensions than the steel ship and, in consequence, must have greater hold spaces. For heavy weight cargoes, such as steel, coal or oil, in which the dead-weight capacity is reached before the hold spaces are filled, it is apparent that steel has an advantage over concrete as a material of construction, assuming that the construction and operating costs are equal. For bulky cargoes, such as ordinary package goods, cotton, fruit or other materials for which the space required exceeds about 70 cu. ft. to the ton, the concrete ship will actually carry more dead weight than the steel ship for the reason that the hold spaces of the steel ship will be filled before dead-weight capacity is reached.

The cost of the small cargo vessels, leaving out of consideration the "Atlantus," which was the first vessel built, varies from $210- to $300-per dead-weight ton. The cost of the 7,500-ton tankers will vary between $200- to $250-per dead-weight ton. These figures are based upon the nominal dead-weight carrying capacity rather than the actual. These costs naturally include certain experimental work and other expenditures which could be reduced on future work, so that the above experience is not a sufficient basis on which to forecast the costs under peace conditions and skillful management.

No definite conclusions should be drawn as yet from the experiences with these vessels. It should be borne in mind that all of the vessels were under construction at approximately the same time and that there was little chance to profit by experience. When it is remembered that these were the first vessels ever attempted of this size, the showing is not discouraging. The only general conclusion that may be drawn from the experience of the ships constructed under the direction of the Emergency Fleet Corporation seems to be that it is possible to construct ships of concrete in about the same time and for approximately the same cost as the corresponding steel ships. This indicates that, after there has been more experience in the art, it will be possible to reduce both the cost and the time for construction.

There remains also the question of length of life of concrete ships. Only time can safely answer this question, although it should be stated that the brief experience of the "Faith" and the Emergency Fleet vessels has disclosed no serious inherent weakness to shorten the life of the concrete ship.

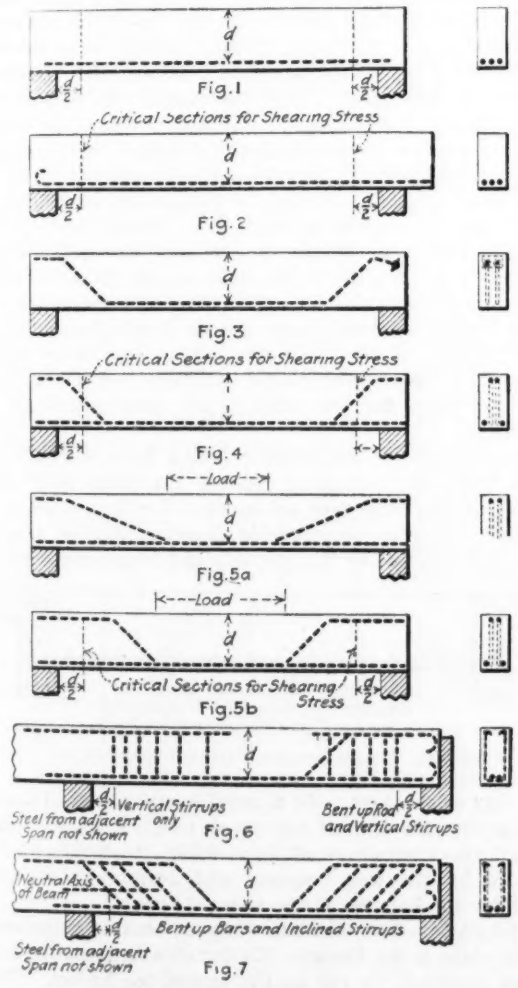
Barges and canal boats, in order to have a commercial future, must apparently overcome two objections—first, a reduction in cost as compared with wood, and this may come through experience in design and construction; and, second, the development of a method to offset the damage sustained to the hull from slight collisions with tugs or other boats or in docking.

Concrete Shear Values Proposed To Concrete Institute

Committee Report Establishes Unit Values and Standards of Design Based on Survey of Available Tests—Recommended Practice for Design Included

Abstract of a report of Committee on Unit Values for Vertical Shear of the American Concrete Institute. Presented to the Annual Convention, at Chicago, Feb. 16, 1920. The committee comprises W. P. Anderson, A. B. MacMillan, C. L. Post, H. A. Ward and A. R. Lord, Chairman. It was accepted and the recommendations at the end passed to letter ballot for adoption as Recommended Practice of the Institute.

THE committee has studied in detail the principal test data on shear in reinforced-concrete members as secured and published by American investigators. Only two European authorities have been consulted. In using the data of the pioneer tests, certain precautions are naturally required. Beams with vertical stirrups generally made a poor showing on account of the fact that the upper ends of the stirrups were not anchored, except by bond on a very short length of straight bar. In some tests considerable web reinforcement was present but it was so disposed as to permit of a failure in diagonal tension in portions of the web not reinforced.



FIGS. 1 TO 7. DIFFERENT TYPES OF SHEAR REINFORCEMENT IN BEAMS

In a number of tests, the diameter of the stirrup rod was too large in proportion to the depth of the beam. The importance of anchoring both the longitudinal and the web steel was not appreciated until after these tests had been made.

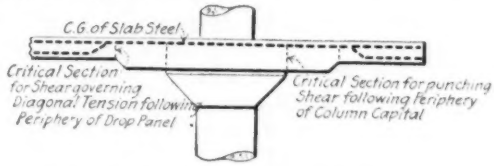

C.G. of Slab Steel
Critical Section for Shear governing Diagonal Tension following Periphery of Drop Panel
Critical Section for punching Shear following Periphery of Column Capital

FIG. 8. SHEAR STANDARDS FOR FLAT SLABS

The notation used in this report is as follows:

V = Total vertical shear at any section.
V' = Vertical shear carried by the web reinforcement.
$v = V/bjd$ = Unit vertical shearing stress.
d = Depth from compressive face to c.g. of tensile steel in inches.
b = Breadth of beam.
b' = Breadth of stem of T-beam or web of I-beam.
A_s = Area of longitudinal steel.
A_v = Area of shear steel in section of beam considered.
j = Ratio of lever arm of resistance couple to depth d.
$p = A_s/bd$ = Longitudinal steel ratio.
$r = A_v/ba$ = Shear steel ratio.
a = Spacing of shear steel measured perpendicular to its direction.
f_c = Ultimate strength of concrete cylinders at 28 days (or at time of test in considering test data).
f_v = Tensile stress in web reinforcement.

Except where v is noted as the unit punching shearing stress, it is used as a shearing stress index governing the value of the diagonal tension in the web as is the present common practice.

Beams Without Web Reinforcement

Type I (Fig. 1) shows the ordinary test beam without web reinforcement and without any special attempt to anchor the longitudinal steel. Such beams have only a very limited use in building construction, mainly in the form of lintels over door or window openings. For this type of beam, the shear resistance depends, primarily, on the tensile strength of the concrete. The tests indicate that the ultimate value of $v = (V/bjd)$ computed on a section distant $\frac{1}{2}d$ from the face of the

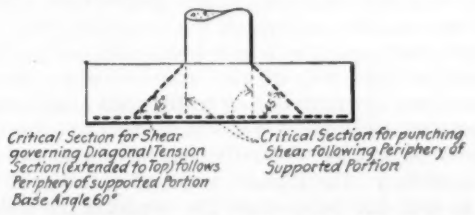

Critical Section for Shear governing Diagonal Tension Section (extended to Top) follows Periphery of supported Portion Base Angle 60°
Critical Section for punching Shear following Periphery of Supported Portion

FIG. 9. SHEAR STANDARDS FOR ISOLATED FOOTINGS

support varies from $0.04f'_c$ to $0.07f'_c$ and averages about $0.06f_c$. Where the longitudinal bars were anchored at the ends by mechanical contrivances or otherwise, higher values were obtained, as noted below.

Type II. Where the longitudinal bars are anchored

either by means of a half circular hook of adequate size, by nuts and washers or other auxiliary devices, or by bond on the bars over or beyond the support, a considerably increased shearing resistance is secured. See

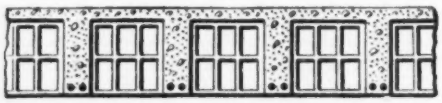


FIG. 10. TILE AND CONCRETE JOINT CONSTRUCTION

Fig. 2 for two examples of effective anchorage. The ultimate value of v from tests varies from $0.06f'_c$ to $0.10f'_c$ and averages about $0.08f'_c$. Certain tests in which half circular hooks were used showed very high values, up to $0.14f'_c$, but these exceptional results have not been included in the average.

Beams With Web Reinforcement

Type III. When all the longitudinal bars are bent up to the top of the beam at the ends, no increased shear resistance is secured unless the ends are anchored. With anchored ends, values as high as $0.08f'_c$ were found, but in other tests no increase was found, and no increase in design stress would seem to be warranted. See Fig. 3.

Type IV. When half the longitudinal steel is carried through in the bottom and half bent up near the ends, additional shearing resistance is secured even though

FIG. 11. MECHANICAL ANCHORAGE OF LONGITUDINAL RODS

the ends are not specially anchored. For this condition, values of v vary from $0.07f'_c$ to $0.12f'_c$ with individual values as high as $0.18f'_c$. The average values and the bulk of the data is at about $0.11f'_c$. See Fig. 4.

Type V. When the bent-up bars of Type IV are inclined in a single plane at a very flat slope, extending from the bottom of the beam at the quarter or third point to the top of the beam over the support, the results are conflicting. See Fig. 5*a*. High values of v were obtained with this arrangement, and also some low values. The construction in which the bent-up bars reach the top of the slab at a considerable distance from the edge of the support were decidedly erratic. See Fig. 5*b*.

Type VI. When the web steel is properly designed to assist the concrete in carrying the shear and when both the web steel and the longitudinal steel are properly anchored at both ends of each rod and when the size of bars is not disproportionate to the span length and to the depth of the beam, very great increases in the value of v may be secured, depending on the amount of web steel employed. The highest value of r (ratio of web steel to web concrete) thus far reported in tests is 0.06. Ultimate values of v in excess of $0.4f'_c$ have been secured in several tests and the data is consistent. With the same value of r the same shearing resistance seems to result, regardless of the direction of the web steel—between the limits of the vertical and an angle of 60° with the vertical (the inclined bar being placed in the tension direction, of course). With large values of r, the quality of the concrete becomes relatively less important provided sufficient strength is present to resist the diagonal compression and the direct shearing stresses (as distinguished from the diagonal tension stresses). The diagonal compression is much higher where vertical stirrups are used than where inclined web bars are used.

Recent tests have brought out strikingly the importance of anchorage of both longitudinal and web reinforcement. In simple beams in which the longitudinals were anchored by means of half circular hooks at the ends, the tensile stress just inside the hook was measured to be over one-half of the stress at the point

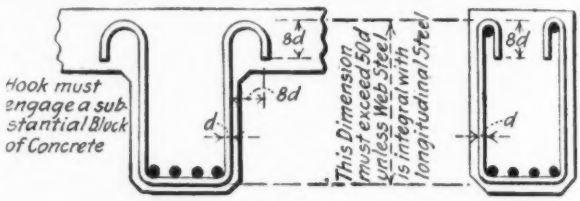


FIG. 12. ANCHORAGE OF STIRRUPS

of maximum moment in some instances and generally as much as one-third. Without such hooks, failures would have occurred due to lack of adequate anchorage of longitudinal bars long before the web steel reached its yield point, and such failures would have closely resembled a true diagonal tension failure, due to overstress of the steel. The importance of mechanical anchorage of the stirrups is obvious. In no other reinforcing member do we attempt to develop a full working stress in so short an embedded length and the attempt is almost certainly doomed to failure unless the best anchorage is provided at each end. Recent tests show clearly that it is unsafe to use bars whose diameter exceeds 1/40 to 1/50 of the beam depth, for even with the stirrup anchored on other steel at each end such bars slipped in some cases before developing a yield point stress. A ¾-in. diameter bar was too large for a beam 36 in. deep when placed vertically and a 1-in. bar was too large for the same depth when placed on a 45° slope.

Recent tests of rectangular beams have shown that even when the web steel reaches the yield point the stress in this steel does not account for the entire web tension. A very considerable diagonal tension resistance is furnished by the concrete and longitudinal bars,

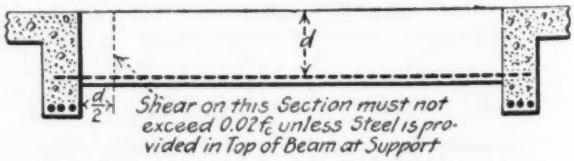


FIG. 13. BEAM FRAMED MONOLITHICALLY

and this would seem to be a satisfactory, practical foundation for the almost universal practice of allowing a unit shearing stress of from $0.02f'_c$ to $0.03f'_c$ to be carried by the web concrete and designing the web steel for the balance of the vertical shear.

Flat Slabs.—The ultimate diagonal tension resistance of flat slabs is not known. No flat slab construction has failed in shear, so far as the committee knows. The test of the Western Newspaper Union building, which was not carried to destruction and in which no meas-

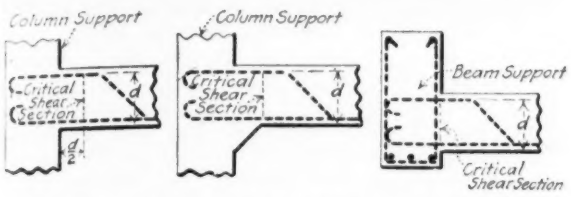


FIG. 14. LOCATION OF CRITICAL SHEAR SECTIONS

urement of the diagonal tension stress was attempted, showed a resistance of about 240 lb. per sq.in. as the maximum load, computed the *jd* depth on the surface of a frustum of a pyramid with 60° base angle and passing through the edge of the column capital. The University of Illinois tests of cantilever slab showed bond of tension failures, while the shear was much below this figure. The Chicago practice of allowing $0.03f'_c$ on the periphery of the drop would appear to be safe, provided the tension steel is adequately anchored beyond the edge of the drop. (See Fig. 8). The severe test required of all concrete buildings in Chicago is a further indication that an adequote factor of safety is provided.

Footings.—Tests by the University of Illinois, reported in Bulletin 67, indicate that the value of v (for diagonal tension) may be figured at a distance from the face of the pier equal to d and that on this section the resistance is equal to that of a beam without web reinforcement. The method contained in this report is in quite general use and is somewhat more conservative than the above.

Where foundation members are reinforced for diagonal tension, the values of v will depend on the conditions set forth under Type VI above.

Tile and Concrete Joist Construction.—Tests indicate positively that in this type, when the joints in adjacent rows of tile are staggered, the tile is very effective in taking shear. Test pieces, without web reinforcement and with no special anchorage of the longitudinal bars, show values of v fully comparable with values for beams of the same type, when the value of v is figured on the basis of all the available web area of both concrete and tile ribs. Figuring the available b as the width of the concrete joist plus the thickness of one tile rib, as is Chicago practice, gives values of v for this type of from $0.10f'_c$ to $0.13f'_c$ even though failure was not in diagonal tension. Figuring b as the breadth of the concrete joists the web thickness of alternate tiles, the values of v vary from $0.07f'_c$ to $0.09f'_c$ (failure occurring by direct tension). Fig. 10 shows the shear section considered effective in this report.

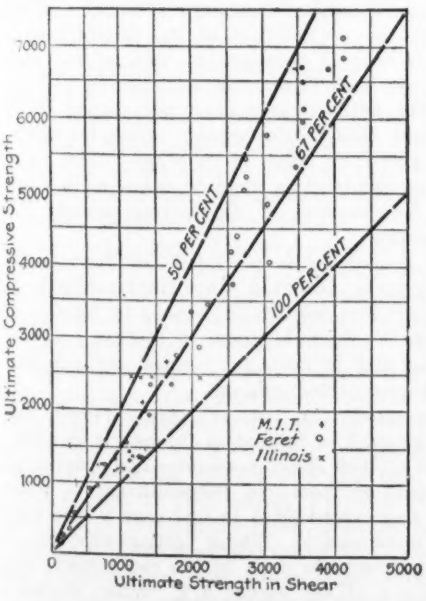


FIG. 15. DATA ON RESISTANCE OF CONCRETE TO (PUNCHING) SHEAR

Concrete joist floors without tile fillers should develop the same shear resistance as beams of the same types.

Punching Shear.—A study of tests show an ultimate resistance of concrete to punching shear which practically never falls below one-half of the ultimate crushing strength. For weaker concrete, the ratio of punching shear to compressive strength is higher. Test data is plotted in Fig. 15.

Recommended Practice for Design

All allowances for design unit shearing stresses in the following sections are predicated on proper design of the longitudinal reinforcement to effectively resist all positive and negative moments, as prescribed in the report on Standard Building Regulations for the Use of Reinforced Concrete as submitted by the American Concrete Institute Committee in February, 1920. Wherever web reinforcement is used it must be adequately anchored at both ends.

Members with Web Reinforcement—When adequate mechanical anchorage of both web and longitudinal rods is provided, the concrete may be figured to carry a unit vertical shearing stress equal to $0.025f'_c$ and the remainder of the shear shall be carried by web bars designed according to the formula

$$A_v = \frac{V'a}{f_v jd}$$

in which

A_v = Area of web member.
a = Spacing of web members perpendicular to their direction.
V' = Shear taken by steel.
f_v = Stress in web member.
jd = Lever arm of moment couple in beam.

Properly anchored bent-up longitudinal bars may be considered as web reinforcement. The maximum unit shearing stress shall not exceed $0.12f'_c$ in any case.

When adequate mechanical anchorage of the longitudinal rods as defined in the next paragraph is not provided, the maximum unit shearing stress shall not exceed $0.06f'_c$, of which $0.02f'_c$ may be considered to be taken by the concrete and the remainder of the shear taken by the web bars designed as above. Web rods must be adequately anchored in all cases.

Adequate mechanical anchorage of the bottom longitudinal steel for positive moments shall consist of carrying the reinforcement a sufficient distance beyond the point of inflection to develop the assumed tension in the reinforcement at the point of inflection by bond between the end of the bar and the point of inflection of the member (never to a less distance than one inch from the center of the support or in case of wide supports to not less than 12 in. of embedment in the support), or of bending the end of the bars over the support to a half circle of diameter not less than 8 times the diameter of the bar, or by any device that will transmit the tension on the bar to the concrete over the support at a compressive stress of not over $0.50f'_c$. The tension in the bar, at the point of inflection to be resisted by the anchorage, shall be taken for this computation as not less than one-third of the maximum safe tension in the bar. Reinforcement for negative moment

shall be thoroughly anchored at the support and extend into the span a sufficient distance to adequately provide for negative tension by bond. Simply supported beams shall have the lo..gitudinal steel anchored by hooks of diameter specified above or by an equivalent anchorage, the tensile stress at the edge of the support being taken as one-third of the maximum safe tension in the bar.

Anchorage of the web steel shall consist of continuity of the web member with the longitudinal member, or of carrying the web member about at least two sides of a longitudinal bar at both ends, or of carrying the web member about at least two sides of a longitudinal member at one end and making a half circular hook at the other end of a diameter not less than eight times the diameter of the web rod. In all cases, the bent ends of web bars shall extend at least eight diameters below or above the point of extreme height or depth of the bar. In case the end anchorage is not in bearing on other reinforcing steel, the anchorage shall be such as to engage an adequate amount of concrete to prevent the bar from pulling off a portion of the concrete. In all cases the stirrups shall be carried as close to the upper end lower surfaces as fireproofing requirements will permit. The size of web reinforcing bars which are not either a part of the longitudinal steel or welded thereto shall be such that not less than two-fifths of the maximum design tensile stress in the bar may be developed at design bond stresses in a length of rod equal to $0.4d$. This condition is satisfied for plain round stirrups when the diameter of the bar does not exceed $d/50$. The balance of the tensile stress in the bar may be considered as taken by adequate end anchorage as specified above.

Beams in which no longitudinal reinforcement is provided in the upper portion of the beam adjacent to the support and in which the ends of the beam are built monolithic with other parts of the concrete structure, shall not carry a unit shearing stress in excess of $0.02f'_c$, regardless of amount of web reinforcement provided.

When the shear reinforcement consists of bars bent up at an angle so as to reinforce all sections of the beam in which the unit shearing stress exceeds $0.02f'_c$ the design may be made as follows:

$$A_v f_v = V' \sec \alpha$$

Where A_v = Area of bent up shear bars.
f_v = Stress in bent up shear bars.
V' = Total shear at end of span as prescribed for moment less the shearing resistance of the concrete at a unit stress of $0.02f'_c$ over the area $b'jd$.
d = Angle between bent up rod and the vertical.

The maximum unit shearing stress shall not exceed $0.06f'_c$ with this arrangement of web steel and the longitudinal steel shall be adequately anchored as defined above in all cases.

In case the web reinforcement consists solely of inclined shear bars the first bent bar shall bend downward from the plane of the upper reinforcement directly over or within the edge of the support.

Beams Without Web Reinforcement—When the longitudinal steel is not fully anchored, as prescribed above, the unit shearing stress shall not exceed $0.02f'_c$. When the longitudinal steel is fully anchored, as prescribed above, the unit shearing stress shall not exceed $0.03f'_c$.

Critical Section for Shear in Beams—The critical section for shear as governing diagonal tension shall be taken at a distance not greater than one-half the effective depth of the beam ($\frac{1}{2}d$), from the end of the span as prescribed for moment, except that if the edge of the support be less than one-third deeper than the beam itself, the critical section shall be taken at the edge of the support. (See Fig. 13.)

The effective depth of the critical section for shear as governing diagonal tension shall be taken as the depth jd of the beam in the plane of the critical section.

The breadth of the critical section shall be the full breadth of rectangular beams or the breadth of the stem of T-beams or the thickness of the web in beams of I section.

Tile and Concrete Joist Construction—The shearing stresses in tile and concrete joist construction shall not exceed those in beams or slabs of similar reinforcement. The breadth of the effective section for shear, as governing diagonal tension, may be taken as the thickness of the concrete joist plus one-half the thickness of the vertical webs of the tile provided that the joints in one row come opposite the centers of tile in adjoining rows on either side.

Where the tile joints are not staggered, only the concrete joists may be considered effective in resisting shear.

Flat Slab Construction—In flat slab construction where a drop panel is used adjoining the column, the shearing stress, as governing diagonal tension, figured on the jd depth on a vertical section along the periphery of the drop, shall not exceed $0.03f'_c$. (See Fig. 8.)

In flat slab construction, with or without drop panels, the shearing stress as governing diagonal tension, figured between the compression face of the slab or drop and the level of the center of gravity of the reinforcing steel, on the surface of the frustum o fa cone or pyramid passing through the periphery of the column capital and having a base angle of 45°, shall not exceed $0.035f'_c$.

Footings—In footings carrying a single column or load, the shearing stress, as governing diagonal tension, figured between the level of the centroid of the compressive stresses and the level of the center of gravity of the reinforcing steel on the surface of the frustum of a cone or pyramid passing through the base of the supported column or loaded member and having a base angle of 45° the unit stresses shall not exceed those in beams without web reinforcement. Especial attention shall be given to bond in footings. The total vertical shear on this section shall be taken as the upward pressure on the area of the footing outside the base of this section.

If adequate anchorage is provided for the tensile steel and adequately anchored web reinforcement is also provided such web reinforcement may be figured in accordance with the formula given in section I above. Such calculations may be made for vertical sections concentric with the supported column.

For footings supporting two or more columns, the shearing stresses shall be figured as for beams or slabs.

Arrangement of Web Reinforcement—The spacing of web reinforcement as measured perpendicular to their direction shall not exceed $3d/4$ in any case where web reinforcement is necessary. Where vertical stirrups or web members inclined less than 30° to the vertical are used, the spacing shall not exceed $d/2$. When the unit shearing stress exceeds $0.06f'_c$ the spacing of the web

reinforcement shall not exceed $d/2$ in any case, nor $d/3$ for vertical stirrups or web steel inclined less than 30° with the vertical.

The first vertical stirrup shall be placed not farther than $d/2$ from the face of the support in any case. The first inclined stirrup or bent-up rod shall reach the level of the upper longitudinal steel at a distance not greater than $d/2$ from the edge of the support if the bottom longitudinal steel is adequately anchored and at the edge of the web support if the longitudinal steel is not anchored. Web members may be placed at any angle between 0 and 60 degrees with the vertical, provided that, if inclined, they shall be inclined in the proper direction to take tension, rather than compression, in the web.

Punching Shear—Punching shear shall be figured on a vertical section through the periphery of the smaller member. The unit shearing stress in punching shear, figured on the full depth d to the center of gravity of the reinforcement, shall not exceed $0.1f'_c$.

When the depth of the supported or supporting member is less than one-fifteenth of the span in the case of beams or slabs, or less than one-third of the overhang in the case of cantilevers (including footings), the unit shearing stress in punching shear shall not exceed $0.06f'_c$.

More Light on Protecting Concrete Against Fire

Tests Show That Limestone Aggregate Is Highly Fire Resistant and That Mesh Helps Siliceous Aggregate

From the report of the Committee on Fireproofing, American Concrete Institute, presented at the annual convention, Chicago, Feb. 16-18, 1920.

IN FIRE tests of concrete columns made at the Bureau of Standards at Pittsburgh, extensive spalling has invariably taken place in the fire tests of hooped columns from highly siliceous gravels, made in the usual way. Most of the columns tested have had a thickness of 1½ in. of protective concrete over the steel. Two columns from Pittsburgh gravel, with 2½ in. of protective concrete, gave results that were distinctly better than those with protective concrete only 1½ in. thick, and yet so poor, in comparison to those shown by columns from more favorable aggregates, with 1½ in. of protective concrete, that the expedient of securing better protection in the case of columns from highly siliceous gravel, by providing an unusual thickness of protective concrete, does not seem worthy of recommendation. On the other hand, the two columns from Pittsburgh gravel, with a thickness of 1½ in. of protective concrete, reinforced by a light grade of expanded metal, of large mesh, to prevent the loss of protective concrete by spalling, gave fairly satisfactory results. While the results of the test of these columns were not as good as those from columns from limestone, traprock and blast furnace slag aggregates, the loss of strength in the four-hour fire test, as determined by loading to failure in the furnace while the column was still hot, was less than 60 per cent in both cases, which presents a strong contrast to the results from columns from the same aggregate, Pittsburgh gravel, without reinforcement in the protective concrete, which failed under the working load before the four-hour fire test was completed.

Columns from Pittsburgh gravel, with 2½ in. of protective concrete, with light expanded metal reinforcement in the outer concrete to prevent the loss of protective concrete by spalling, could not be loaded to failure in the furnace, at the end of the four-hour fire test, due to the fact that their strength exceeded the load limit of the furnace equipment, which is equivalent to a stress of approximately 3,480 lb. per square inch on the effective area of these columns. When tested cold, after fire test, in a testing machine of high capacity, these columns showed an ultimate strength only slightly lower than that of a similar column, which had not been subjected to fire test. Judging from these results, it would appear that if the protective concrete of columns from highly siliceous gravel aggregates were reinforced with expanded metal so as to prevent loss of protective concrete by spalling, they would be sufficiently protected by the thicknesses of protective concrete recommended fer different conditions in the last report of this committee. The expedient of providing such reinforcement in the protective concrete of columns made from highly siliceous gravels is accordingly included among the recommendations for columns.

Two gravel concrete columns, in which the aggregate was low in quartz content, have been fire-tested. Approximately 90 per cent of the gravel was made up of limestone pebbles and there was a high percentage of limestone in the land. The columns had 1½ in. of protective concrete with no expanded metal. These columns showed no tendency to spall in the fire test and gave comparatively good results in other respects. Neither of them failed under the maximum furnace load when tested hot at the end of the four-hour fire test. When tested cold, after the fire test, the ultimate strength was found, in both cases, to be more than 75 per cent of that of a similar column, which had not been submitted to fire test. These results indicate that gravels and sands that are very high in limestone content are suitable for use in fire-resistive concrete. It is probable that all gravels that are low in quartz may prove, on investigation, to be free from the spalling tendency. How high a proportion of quartz can be included in gravels without the resulting concretes spalling under fire test conditions cannot be determined from the tests thus far made. The evidence now available appears to be sufficient, however, to justify the recommendation that gravels high in limestone content be given a preference, for fire-resistive concrete, over highly siliceous gravels.

The recommendatons of this committee may be stated as follows:

1. That in concrete columns where four-hour protection is required, protective material not less than 2 in. in thickness shall be provided over the steel. In columns in which a high percentage of steel is used, increasing the importance of affording it ample protection, the thickness of protective material shall be 2½ in. for four-hour protection, and special care shall be given to the accurate placing of the steel in the forms, to avoid inadequate protection on any side.

2. That for fire-resistive construction, limestone, traprock, blast furnace slag, well burned clay and gravels composed largely of limestone pebbles be given a preference over highly siliceous gravels.

3. That where highly siliceous gravel aggregate is to be used, in columns without hooping, and with no special

safeguards, round columns be given a preference over rectangular ones.

4. That where highly siliceous gravel aggregate is to be used, all columns, but especially rectangular columns and round columns with spiral reinforcement, be safeguarded by means of one of the following expedients:

(*a*) Placing expanded metal or other high weight large mesh reinforcement in the outer concrete to prevent the loss of protective concrete by spalling.

(*b*) Giving columns additional protection of approximately 1 in. of cement plaster, either on metal lath or reinforced with light expanded metal or other suitable material.

Highway Paved for Only Half Its Width, Pending More Funds

ON THE theory that "half a loaf is better than no bread" a portion of the Siskiyou grade in southern Oregon was paved for half its width at a time when funds for paving the entire road were not available. The maintenance problem has long been more serious

OREGON HIGHWAY PAVED FOR HALF ITS WIDTH

on this particular stretch than on any other part of the Pacific Highway which is the through route followed by Washington-California traffic. It is the only approach to the Siskiyou Pass (where the California line is crossed), includes some of the heaviest grades on the through route and lies in non-tributary territory.

The 8-ft. strip of 6-in. concrete was laid on the inside of the graded bench, the plan being to place another width beside this later on. By this expedient motorists traveled on pavement instead of a bad mountain road for a considerable period.

Motion Study of Side Launching of 6,000-Ton Vessel

Experimental Research for Fleet Corporation Gives Accurate Record of Positions and Immergence of Ship

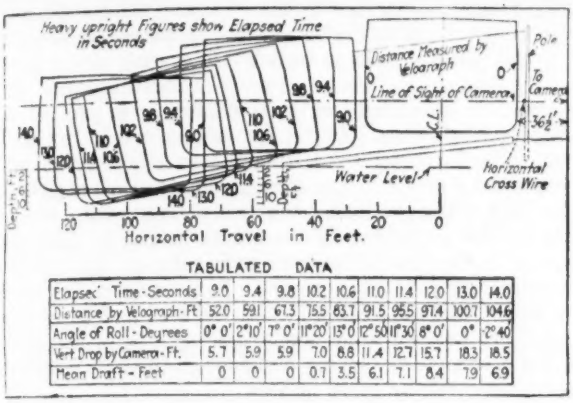
CAREFUL instrumental observations of the behavior of a 6,000-ton steel vessel during side launching were conducted by the research engineers of the Emergency Fleet Corporation recently, at the yard of the Merrill-Stevens Shipbuilding Corporation, Jacksonville, Fla. The vessel on which the observations were made was the steamship "Wekika," a hull of length 334 ft. 6 in. between perpendiculars, molded depth 27 ft. 6 in., molded beam 48 ft., and light draft 7 ft. 4 in. The ship, when completed, will weigh 2,400 tons, but its weight at launching was about 2,100 tons, and the draft at that time 4.55 ft. forward and 8.55 ft. aft. The primary reason for making the observations was to determine the maximum immergence of a vessel in side launching, as both at this yard and at some others much money and labor could be saved if the dredging for the slips could be limited to the minimum required.

The information given in the present article, together with the diagrams reproduced, was obtained from a full report (unpublished) of the tests, made to the Emergency Fleet Corporation by T. R. McMillan and H. R. Thomas, Research Engineers for the corporation.

The main instruments used for the observations were a modification of the "strainagraph" used by the same department in studies of stresses in ships, and the pitch-and-roll recorder used in connection with the same work; certain auxiliary instruments were also arranged, and very valuable use was made of a motion-picture camera. The modified strainagraphs were used as recording instruments to trace a record of the movement of the ship down the launching ways, as furnished by the revolutions of a wheel from which was unreeled a cord attached to a fixed point on the bank, the instruments being on the ship. A time scale was obtained by deflections of a separate pen on each recorder, actuated through electric contact made by a clock supplemented by auxiliary time-indication means.

Several recording pressure-gages, of the type devised for measuring the pressure of water at some particular point of the ship below the water line, which had been used in connection with studies of ship stresses as affected by wave action, were attached to points near the bilge of the ship in the hope of obtaining from them a true record of the vertical position of the ship with respect to water level during its plunge. The results were not altogether satisfactory, however; the best data for vertical position were derived from pictures made by a motion-picture camera set up on land, properly leveled, and directed at a large target of level-rod style painted on the side of the ship; a horizontal wire stretched in front of the camera gave a reference line by which this target could be read. Incidentally, these exposures of the target furnished an excellent check on the distance measurements, since the size of the target image in the successive pictures yielded, by computation, a value for the distance to the ship.

A graphical summary of all the essential data on the motion of the ship derived from the measurements is presented in the "launching diagram" Fig. 1, herewith In this are plotted successive positions of the 'midships



TABULATED DATA

Elapsed Time - Seconds	9.0	9.4	9.8	10.2	10.6	11.0	11.4	12.0	13.0	14.0
Distance by Velograph - Ft.	52.0	59.1	67.3	75.5	83.7	91.5	95.5	97.4	100.7	104.6
Angle of Roll - Degrees	0° 0'	2°10'	7° 0'	11°20'	13° 0'	12° 50'	11° 30'	8° 0'	0°	-2° 40
Vert. Drop by Camera - Ft.	5.7	5.9	5.9	7.0	8.8	11.4	12.7	15.7	18.3	18.5
Mean Draft - Feet	0	0	0	0.7	3.5	6.1	7.1	8.4	7.9	6.9

FIG. 1. MOTION OF STEAMER "WEKIKA" IN SIDE LAUNCHING AS DETERMINED BY MEASUREMENTS

cross-section of the vessel according to distance, height and slope data from the measurements. The ringed figures adjacent to the successive outline represent seconds from the moment of starting.

At 9.0 sec. after release, the hull was still level, but just about to leave the ways. At 9.4 sec. it had already begun to tip, the center-line portion of the cradle having gone off the ways. All the successive sections from 9.0 to 11.4 sec. in the diagram represent equal time intervals of 0.4 sec., so that the spaces between the successive outlines give a representation of the speed of motion of the hull. It will be seen that although the outboard bilge dipped into the water just before 9.8 sec., this immersion did not check the speed of the vessel, though it soon brought the tipping action to rest. From about 10.2 sec. to 11.4 sec., this latter being practically the time of maximum immergence, the outward inclination of the hull remained about constant, the vessel sliding steadily deeper into the water. In spite of this the speed appears to have increased, until very near to the time of maximum immergence, when a retarding effect seemed to develop quite suddenly, especially at about 11.4 sec., when the inboard bilge got well under water.

A quite different graphical record of the observation results is given in Fig. 2, which represents plotted values of velocity acceleration and coefficient of friction, on a base of time as well as on a base of distance. As will be seen, the maximum velocity of the hull reached nearly 20 ft. per sec.; the acceleration, which throughout most of the launching movement was quite

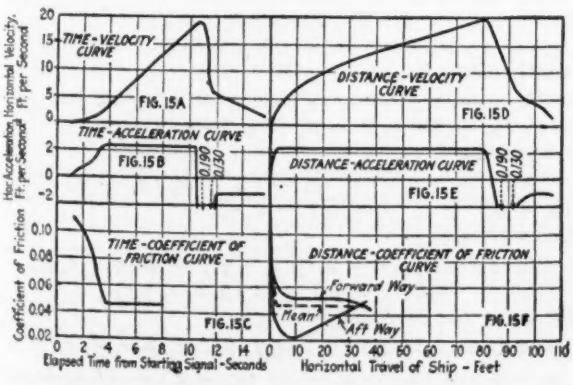


FIG. 2. VELOCITY, ACCELERATION AND FRICTION-COEFFICIENT LAUNCHING OF "WEKIKA"

constant, was a little over 2 ft. per sec. at the maximum; and the friction coefficient after the start was about 0.046.

One curious feature of the launching movement was that the hull left the end of the ways parallel to its initial position, although at an intermediate stage of the movement it was several feet out of line. The bow started considerably quicker than the stern, it appears, possibly due to slightly greater inclination of the ways near the bow. After a time, however, the stern portion caught up with the bow, and thereafter the movement was parallel to itself. The authors of the report concluded that the greater intensity of pressure under the cradles near the stern reduced the friction coefficient here considerably below that of the bow cradles, this fact accounting for the catching up of the stern. The average pressure of the ship on the grease was about 1.6 tons per sq.ft., though the precise values of pressure in the forward and after portions are not known. Just before the ship left the ways, the grease heated to the smoking point, and from the motion curves a material increase in friction on the after ways between 10 ft. and 35 ft. of travel was deduced. This possibly is chargeable to thinning out of the grease under pressure, with simultaneous heating.

Developing Water Storage on Two California Streams

Schedule Has Been Prepared for Construction of Storage Reservoirs on San Joaquin and Kern Rivers Covering Next Eight Years

COMPREHENSIVE plans for developing water power on the San Joaquin and Kern Rivers in Southern California have been laid out by the Southern California Edison Co. The schedule is arranged to fit the company's needs as nearly as may be predicted for the next seven or eight years. Estimates have been made for the necessary expenditures year by year and the dates have been set, approximately, on which the several plants are to add this power to the transmission network.

On the Big Creek watershed, which is tributary to the San Joaquin River, two plants, Nos. 1 and 2, are already in operation and seven more are contemplated.

On Kern River a similarly comprehensive schedule has been laid out with dates of completion set as far ahead as 1927. The two plants now operating on that stream are to be supplemented with five more so that ultimately a total of 643,000 kw. will be developed in all seven plants on Kern River. A comprehensive study here has lead to the decision that the use of maximum storage and head, calls for storing water in ten reservoirs. The total capacity of these will be 456,000 acre-feet. With the exception of the smallest, they will all be between 5,000 and 7,500 ft. elevation.

To develop the head for the several plants tunnel work as follows has been tentatively decided upon:

Capacity in sec.-ft....	125	200	300	400	500	600	850	1,000	2,000
Length in Miles.....	5	2	6	18	2	30	2	19	11

In both Kern and Big Creek Basins the idea has been to lay out the entire series of plants in sufficient detail to make sure that the program adopted would secure the maximum power from the combination. Then the order of development is decided as the load on the company's lines increases and as the most economical construction plan dictates.

Sequence of Notes for and Calculation of Cross-Section

Orderly Arrangement of Notes Reduces Chances of Error—Generalized Rule Adapted to Other Than Railroad Sections

By O. G. Bunsen
Locating Engineer, Fort Worth and Mineral Wells Interurban Survey

PROPER sequence in field notes for railroad cross-sections greatly reduces the chances of error in computing complicated areas, and makes unnecessary the drawing of the sections. The generalization of the rules for arrangement of notes and computation also adapts them to other than the ordinary forms of railroad sections, thus enhancing their usefulness. The new rules are developments of a rule formulated by the author and published in *Engineering News* of Aug. 27, 1914, p. 457.

For reference in this article, the rule previously published and slightly more generalized will be called in this article Rule B, and a subsidiary rule since developed by the writer, respecting the form and recording of the field notes, will be called Rule A. The latter adopts Rule B to forms of sections or polygons other than the ordinary form of railroad cross-section, thereby enhancing the usefulness and scope of Rule B very materially.

Taking any point as the origin of measurement, and recording the field notes in the usual fractional form in which the denominator is the horizontal measurement, or the distance out from the origin, and the numerator is the vertical measurement, or the height (cut or fill), of the rod reading above or below the horizontal axis through the origin, then the subsidiary rule is as follows:

Rule A—Beginning at any summit of the polygon or section, measure and record its coördinates, and, following the perimeter of the polygon, successively measure and record the coördinates of all its summits, recording last the coördinates of the first summit again.

Then the generalized rule of calculation, Rule B of any section of area A, whether the origin be without, on, or within the perimeter of the section, is as follows:

Rule B—2 A = algebraic sum of the products obtained by multiplying each distance out by the difference of the adjacent heights either side of the distance out, *always* taking the height between the origin and the distance out as the minuend.

The evolution of the rule was as follows:

Fig. 1, of area A, is an ordinary railroad cross-section in cut; k is the height at the center, c, c_1, c_2 and c_4 are also called the end heights; d_1, d_2, d_3 and d_4 are the distance out, b is the half roadbed. O, the origin of measurement, is on the perimeter at the intersection of the center line and the grade line.

Then the usual practice is to write the field notes as shown within the bracket as follows:

$$\frac{o}{b}\left[\frac{c_4\ c_3 \quad k \quad c_1\ c_2}{d_4\ d_3\ Sta.\ No.\ d_1\ d_2}\right]\frac{o}{b}$$

and the rule for calculation to fit this arrangement, as bequeathed to me, is stated:

2A = (sum of the end heights multiplied by one-half the roadbed plus the) algebraic sum of the products obtained by multiplying each distance out by the difference of the adjacent heights either side of the distance out, *always* taking the height between the center and the distance out as the minuend. However, by removing the brackets so as to include o/b at each end as part of the field notes, then all within the parentheses of the above rule is omitted and the rule becomes as printed in *Engineering News*. Again, by writing origin for center, it is the generalized Rule B. In other words the fractional forms o/b are the coördinates that complete the field notes by closing the two polygons into which the section is divided by the center height k. The origin o is the first summit of each polygon, the coördinates of which summit are o/o. It is worth noting that in some railroad sections, b on the left and b on the right are not the same, and including o/b in the field notes prevents overlooking a change in the half roadbed with the resulting error in area.

Case I—Origin outside the perimeter of the section

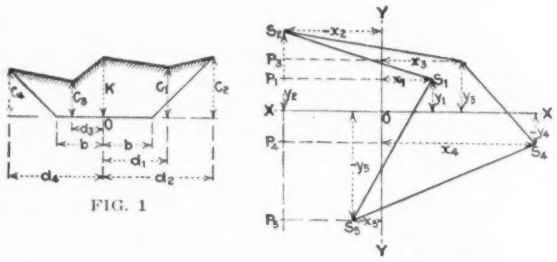


FIG. 2

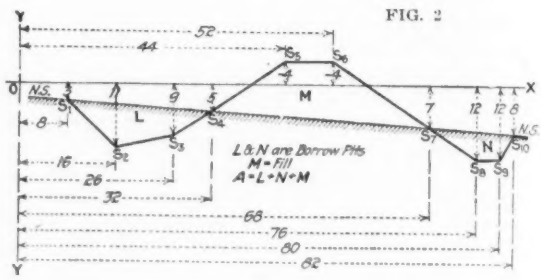


FIG. 3

Fig. 1—Ordinary section in cut. Fig. 2—Section with origin outside the perimeter. Fig. 3—General section showing adaptability of Rules A and B.

or polygon; this is the most useful case for unusual forms.

Following the conventinoal usage as to signs of coördinates, then, according to Rule A, the field notes for Fig. 2, measuring and recording the coördinates of the summits from S_1 to S_5 inclusive are

$$\frac{y_1}{x_1}\ \frac{y_2}{-x_2}\ \frac{y_3}{x_3}\ \frac{-y_4}{x_4}\ \frac{-y_5}{-x_5}\ \frac{y_1}{x_1}$$

and by Rule B

$$2A = -x_1 y_2 - x_2 (y_1 - y_3) + x_3 (y_2 - [-y_4]) + x_4 (y_3 - [-y_5]) - x_5 (-y_4 - x_1 y_5$$

simplifying

$$2A = -x_1 y_2 + x_2 (y_3 - y_1) + x_3 (y_3 + y_4) + x_4 (y_2 + y_5) + x_5 (y_4 + y_1) - x_1 y_5 \qquad (1)$$

Geometrically

$$2A = 2(s_2\ s_3\ p_3) + 2\ (p_3\ s_3\ s_4\ p_4) + 2\ (p_4\ s_4\ s_5\ p_5) - [2\ (s_2\ s_1\ p_1) + 2\ (p_1\ s_1\ s_5\ p_5)]$$

or, using the coördinates

$$2A = (x_2 + x_3)\ (y_2 - y_3) + (2x_3 + x_4 + x_4)\ (y_3 + y_4) + (2x_4 + x_4 - x_5)\ (y_3 - y_4) - [(x_2 + x_1) - (y_2 - y_1) + (2x_2 + x_1 - x_5)\ (y_1 + y_5)]$$

performing the indicated operations and grouping like terms and adding

$$2A = \begin{cases} x_2 y_3 - x_2 y_2 + x_3 y_2 - x_3 y_3 + 2x_2 y_4 + x_3 y_4 + \\ x_4 y_3 + x_4 y_4 + 2x_2 y_5 + x_4 y_5 - x_5 y_4 + \\ x_5 y_4 - x_2 y_1 - x_1 y_2 + x_1 y_4 - x_4 y_5 + x_5 y_1 - \\ x_2 y_3 + 2x_2 y_5 + x_3 y_5 - 2x_2 y_4 - x_4 y_4 - \\ 2x_2 y_5 + x_5 y_5 - x_1 y_1 \end{cases}$$

$$2A = x_2 y_3 + x_3 y_2 + x_3 y_4 + x_4 y_3 + x_4 y_5 + x_5 y_4 - x_3 y_1 - x_1 y_2 - x_1 y_5 + x_5 y_1$$

Regrouping and combining

$$2A = -x_1 y_2 + x_2 (y_3 - y_1) + x_3 (y_3 + y_4) + x_4 (y_3 + y_5) + x_5 (y_4 + y_1) - x_1 y_5 \qquad (2)$$

identical with Eq. (1) adduced from Rule B.

Cases with origin on and with origin within the perimeter are similarly developed.

In practice, resulting areas frequently show negative, due to the manner of taking the coördinates and the position of the section as regards the origin and axis *OX*, but the result is not invalidated. The example given in Fig. 3, besides illustrating this fact, shows the manner of using Rules A and B and their general adaptability and usefulness. In this figure *OX* is the line of sight (hand level or wye level), and it is natural to make the readings above *OX* (obtained with hand level) negative. The natural surface or N.S. is represented by the hatching

In Fig. 3, areas in cut L and N are positive and area in fill M is negative.

Then A = L + N + M and by Rule A

$$\underset{\text{L}}{\left(S_1\ S_2\ S_3\ S_4\ S_1\right)}\ \underset{\text{M}}{\left(S_4\ S_5\ S_6\ S_7\ S_4\right)}\ \underset{\text{N}}{\left(S_7\ S_8\ S_9\ S_{10}\ S_7\right)};$$

then by Rule B.

$$A = L + N + M$$

$$2A = 2L + 2M + 2N$$

$$2L = (8 - \times 11 + 16 \times - 6 + 26 \times 6 + 32 \times 6 + 8 \times 5)\ 2M = (32 \times 4 + 44 \times 9 + 52 \times - 11 + 68 \times - 9 + 32 \times 7)\ 2N = (68 \times - 12 + 76 \times - 5 + 80 \times 4 + 82 \times 5 + 68 \times 8)$$

$$2A = (-88 - 96 + 156 + 192 + 40) + (+128 + 396 - 572 - 612 + 224) + (-816 - 380 + 320 + 410 + 554)$$

$$2A = +204 + (-436) + 78$$

$$A = \text{"L"} \quad \text{"M"} \quad \text{"N"}$$

$$A = 102 + (-218) + 39$$

$$A = \text{cut of } 141 + \text{fill of } 218.$$

Fig. 3 brings out the importance and manner of applying Rule A. In taking the notes in the field, it is likely that the coördinates to S_4 and S_7 will be overlooked, but they must be inserted in the notes to close the polygons L, M and N, either by plotting or by calculation, in order that Rule B may be used. The points S_4 and S_7 correspond to grade points in the ordinary railroad cross-section, but since in such a section the horizontal axis is the grade line and the center or origin is the first summit, the first coördinates are %, and the coördinates to a grade point close the polygon and therefore do not have to be repeated as in the more complex case of Fig. 3.

To sum up, the value of the combination of Rules A and B consists in this, that, having adhered to Rule A in recording the notes for a section of unusual form, or of one in which the position of the origin and the measurement to summits is out of the ordinary, one can be absolutely sure that Rule B will give the area of that section and that there is no need of worry or loss of time in drawing a diagram to satisfy oneself by solving triangles and trapezoids. Take, for example, a section that includes several tracks, borrowpits, spoilbanks, ditches etc.—such sections are ordinarily plotted on cross-section paper and measured with a planimeter, but if a little care in following Rule A is exercised in the field and such points as S_4 and S_7 of Fig. 3 are recorded and the names of the various areas of the section are properly noted, this extra, very considerable work and errors inherent in planimeter work can be avoided by using Rule B. Even where it is necessary or desirable to plot such sections for the purpose of studying the ground and the distribution of material, or for obtaining other information that such pictures give, the areas can still be expeditiously calculated by Rule B from the original field notes far more accurately than they can be measured with a planimeter operated under the usual conditions.

National, State and Municipal Forestry

A FORESTRY program for the United States that takes in states and municipalities as well as the Federal Government has been formulated by the Forest Service of the United States Department of Agriculture, which is issuing circulars dealing with the subject. The Forest Service states that there are in the United States today 100,000,000 acres of idle forest land and that in addition we are "throwing several million acres more of forest land into idleness every year by forest fires and by destructive methods of lumbering." Federal legislation suggested by the Forest Service includes provisions for an extension of Federal forest holdings; co-operation with states in fire protection and silviculture; an appropriation to enable the Secretary of Agriculture to investigate forest taxation practices and to co-operate with state agencies in bringing about improved methods of forest taxation; congressional legislation extending the existing farm loan systems "to include loads for a maximum period of six years for the purchase or improvement of forest land cut over or bearing immature growth"; co-operation with the states in determining what lands are suited to agriculture and to silviculture; and forest surveys and research carried on by the Federal and state governments co-operatively. State legislation is suggested to enable both states and cities to acquire forest lands, particularly cut over areas, and to begin systematic upbuilding of forests. The circular urges that emphasis should be placed upon the value of state and municipal forests for recreation purposes and for the protection of municipal water-supply gathering grounds.

Premixing No Benefit in Concrete

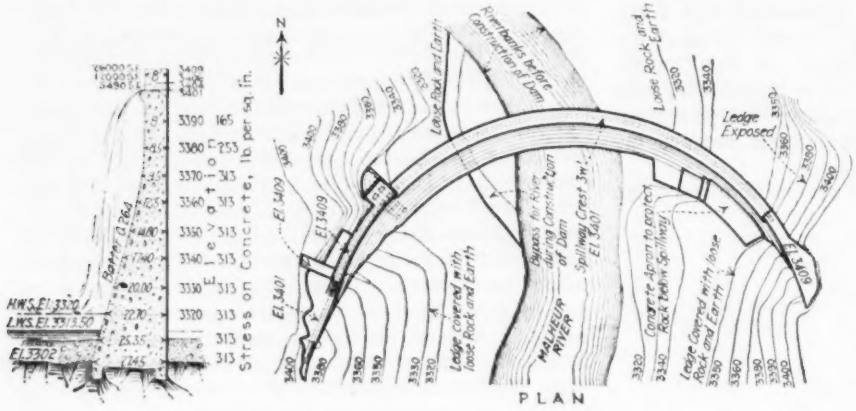
To determine the benefit to strength due to mixing of cement and water for a long period (15 to 30 minutes), and then adding aggregates to produce a concrete instead of the ordinary method of mixing cement, aggregate, and water together for one or two minutes, comparative tests were made last year by the United States Bureau of Standards. The strengths obtained were about the same with the same materials and conditions, indicating that there is no advantage in long premixing of cement and water from the standpoint of strength.

Design Details and Field Methods on Thin Arch Dam

Straddling Trestle Method of Construction Used on Warm Springs Concrete Dam in Oregon—Cobbles Used in Aggregate—Contraction Joints and Drain Pipes Provided

ANOTHER concrete arch dam has been built in the Far West by the use of the straddling trestle such as was described in the Kerhoff dam, *Engineering News-Record*, Feb. 26, 1920, p. 421. This is the Warm Springs dam on the Malheur River in Eastern Oregon, six miles from Riverside. Other features of the structure, which is to impound 170,000 acre-feet of water for irrigating 40,000 acres in the vicinity of Vale and Ontario, are the methods of securing the forms to the struts, the experience with basalt as an aggregate, the use of large-size aggregate rather than plums and the provision for future grouting of the foundation.

Completion of the structure insures water to 12,000 acres partially irrigated and 17,000 acres of new land.



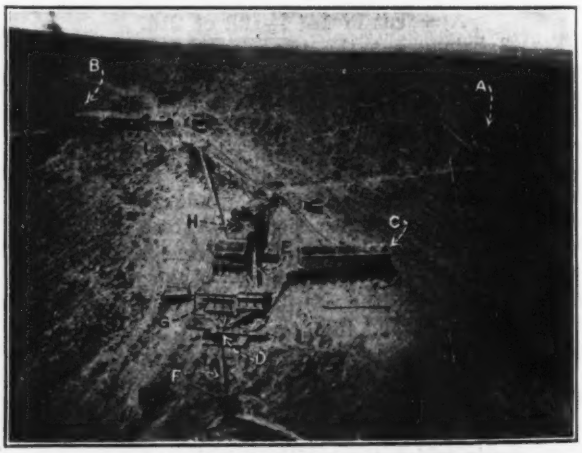
WARM SPRINGS DAM—PLAN AND SECTION SHOWING STRESSES

The remainder of the 40,000 acres is bench land west of Vale and must be supplied by pumping. An alternative plan is to sell this surplus water to the Harper Irrigation District, now being formed 30 mi. upstream from Vale. The reservoir supplements an average direct flow of 60,000 acre-feet from Malheur River. Runoff from the 800 sq.mi. of catchment areas is based on observations from 1914 to 1915. With net evaporation loss from the reservoir estimated at 4 ft. per year and seepage 6 ft. (none estimated to return to the river above the headgates), a yearly diversion of 110,000 acre-feet can be obtained from a capacity of 170,000 acre-feet storage. Had the reservoir been constructed in 1903 the mass diagrams indicate there would have been a shortage 3 years out of 14 for which records were available, the maximum shortage being 10 per cent. Duty of water adopted is 3 ft. in depth on the land during the irrigating season. Distribution losses are estimated at 20 per cent of the water taken out at heads of the main laterals. In main canals, seepage loss for earth sections was estimated at 1 ft. in depth per day over the wet area of canals, and for concrete-lined canals 1 in. in depth.

On top the dam is 549 ft. long, the curved portion being 469 ft., and at the bottom 200 ft. The width at top is 8 ft. and at bottom 27.24 ft. A spillway 324 ft. long, with a freeboard of 8 ft., provides for a runoff of 12,000 sec.-ft. with a depth of 5 ft., or more than double the maximum recorded flood, the highest runoff of record being 5,490 sec.-ft. The dam was designed according to the constant-angle arch theory as propounded by L. R. Jorgensen in the "Transactions" of the American Society of Civil Engineers, vol. LXXVIII, p. 685, 141° 25′ being adopted instead of the theoretical 133° 34′. Fitting this to the contours a maximum upstream radius at the top of 190 ft. is obtained, and as the site is U-shape rather than V-shape, this radius was kept for the upstream face. Transitions to the shorter radii at the bottom of the downstream face are barely noticeable. The shortest radius is 163 ft.

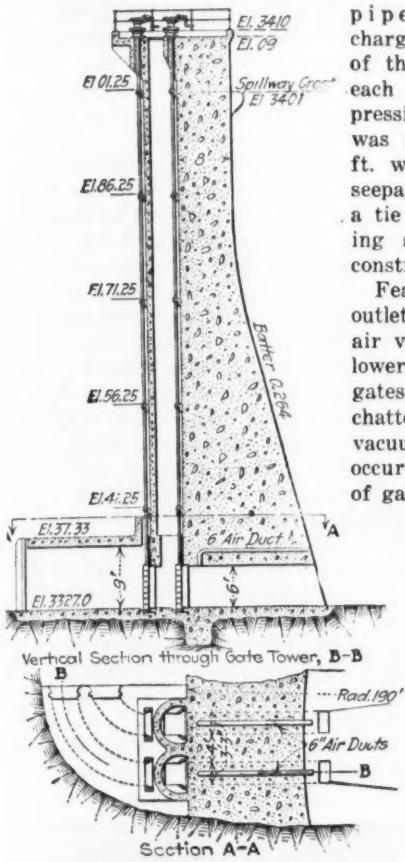
Choice of the arch type over a gravity dam was affected by the mounting cost of materials. In the report, in 1916, on the project by John T. Whistler and John H. Lewis under a co-operative agreement between the U. S. Reclamation Service and the State of Oregon, the cost of a single arch was estimated at 93 to 95 per cent of the cost of a gravity dam. As there was so little difference at that time, the gravity type was recommended. The advancing cost of material and labor, however, made a much greater saving in the use of a single arch. Caring for ice thrust over the whole face of the multiple-arch type was considered too difficult, although the cost in the report was estimated to be 85 to 87 per cent of the gravity type. Stresses in the concrete dam as constructed were held down to 22½ tons per sq.ft.; about 1 ton less than that in the Lake Spaulding dam and in the Salmon Creek dam, Alaska, reported in Mr. Jorgensen's paper.

Four contraction joints divide the dam into approximately five even sections. They are drained by 4-in.



CONSTRUCTION PLANT LAYOUT

A, quarry; B, power house; C, cement shed; D, mixer; E, cobble chute; F, concrete chute; G, sand and gravel bins; H, rock crusher; I, gravel chute; J, unloading platform.

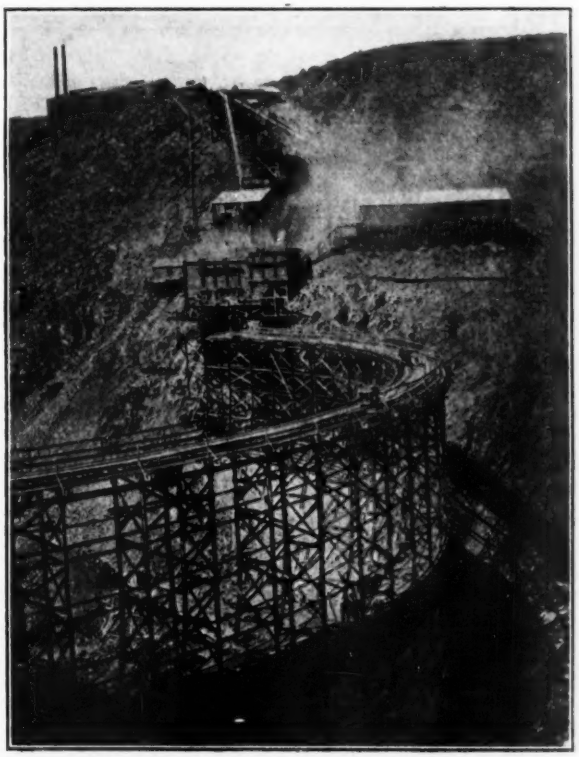


GATE TOWER SECTIONS

pipes which discharge at the base of the dam. Along each joint, a depression 6½ in. deep was constructed 2½ ft. wide to cut off seepage, and act as a tie to the adjoining section when constructed.

Features of the outlet works include air vents below the lower set of sluice gates to prevent chattering from any vacuum that might occur. The first set of gates will get air through the extension of the reinforced semi-circular valve chamber in which the valve stems of the second set rise to the operating stands on top of the dam. Entrance of water to the gates is through a forebay structure, the stop-planked inlets to the latter being at right angles to the face of the dam, the water making a quarter turn so as to pass at right angles through the dam in two openings 3.25 ft. wide by 6 ft. high. This quarter turn brings the conduits through the dam near one end, where the dam is firmly imbedded in the solid rock.

Clearing the foundation was a somewhat simpler process than anticipated, as the bedrock was closer to the surface than the original investigations indicated. This saving was accomplished by moving the dam a few feet above the original location, as indicated by preliminary excavation work. Bedrock consisted of a close-grained basalt with fine seams filled with putty-like clay. To insure tightness, should leakage develop, 2-in. pipes coming to the surface through which drilling may take place for grouting are spaced on 6-ft. centers the length of the dam on its downstream face. Water

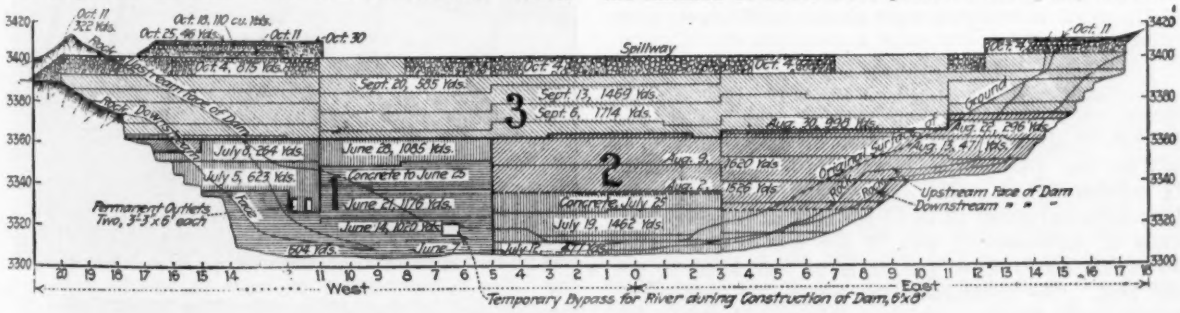


CONCRETING FROM THE FULL HEIGHT TRESTLE

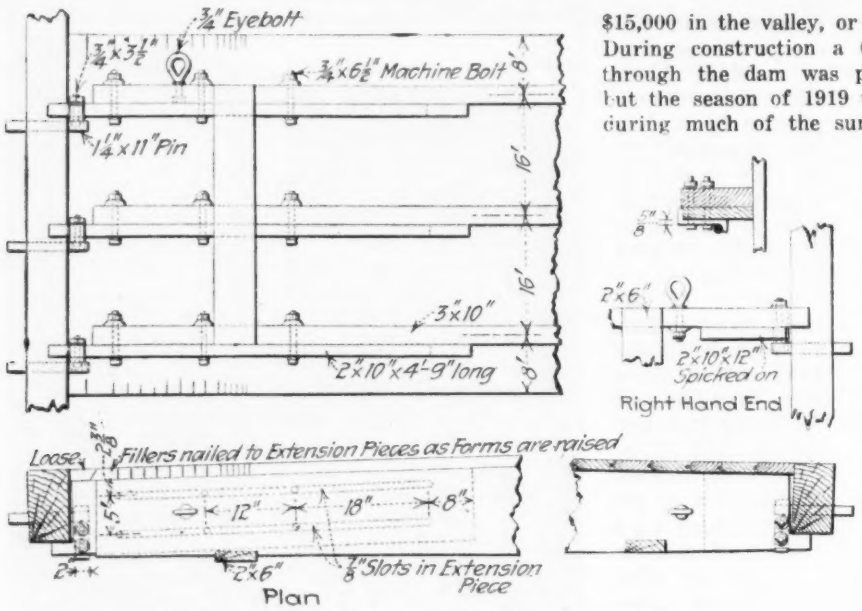
forced through a hollow bit and drill rods, when boring test holes, returned in all cases except one, and that was above bedrock, this indicating tight seams.

Deposition of the concrete was from the top of a trestle spanning the dam section, mounted bottom-dump buckets discharging through an 8-in. flexible iron pipe. The trestle was built in two lifts, the concrete plant being located at one end sufficiently high so that the discharge from the 1-yd. mixer was directly into the buckets on the top level.

Form sheets 4 ft. high and 14 ft. long for the faces of the dam were fitted in place between the legs of the trestle and held there by dowels through the legs. Special forms had to be constructed only adjacent to the gate tower. The accompanying sketches illustrate the details of the manner in which the lugs were secured over the dowels, and how the length was made adjustable by an extension piece on the wales to fit the varying radii of the downstream face. The upstream face was of constant radius, so did not need an extension piece. Anchors holding the trestle legs to the finished concrete were placed 4 ft. apart, the bolt



PROGRESS PROFILE INDICATES ORDER OF WORK



DOWNSTREAM FACE FORMS—WARM SPRINGS DAM

through the trestle leg being secured over the anchor proper, the outer end of which came just to the concrete surface. Enough form sheets were provided to pour two full sections the length of the dam. They were handled from a platform swung from a trolley supported by cantilevers extending out either side from the top of the trestle. Each day's work of depositing concrete approximated 2 ft. in depth and was continuous in each section between expansion joints.

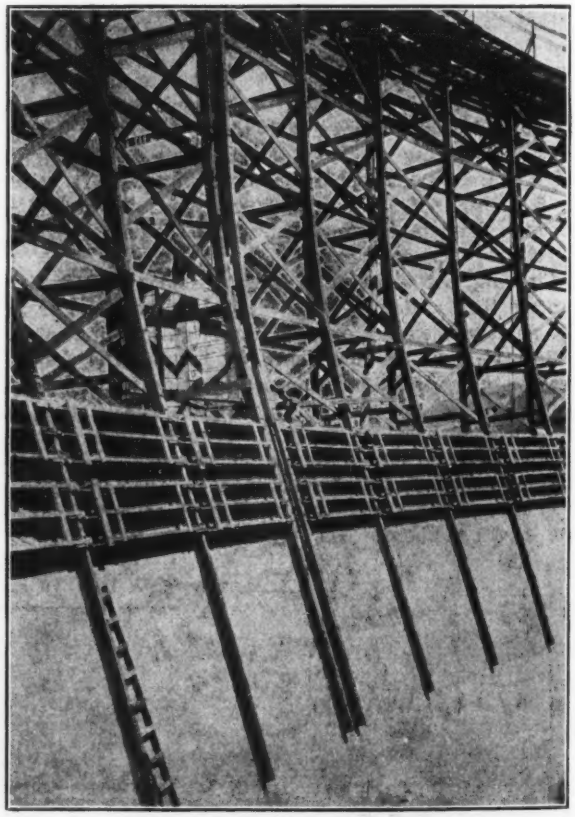
Cobbles Mixed in Concrete

Getting a fine aggregate was one of the largest problems. Crushing the basaltic rock, which was obtained from a ledge about 500 ft. upstream from the construction plant, by shooting it over a Swede trap, was not found to be a success, in that it would pulverize when put through the sand rolls. This verified trials with basalt at other construction plants in the lava country, but sand was so inaccessible, or was thought to be, that the experiment with the local rock was considered worth trying. As the amount the plant could produce was the "neck in the bottle," restricting the concrete to about one-fourth of that expected, diligent search made for river sand resulted in locating a bank of quartzite gravel 4,000 ft. away. This was run through a No. 3 crusher and the sand rolls, and by operating the crushing plant 18 hours per day enough aggregate was provided to run the concrete gang for 9 hours. The 19,412 cu.yd. of concrete were placed in 107 days, averaging 181 cu.yd. per day, with a maximum of 312 cu.yd. in 9 hours.

Aggregate up to 6 in. was used rather than plums, as it could be run through the mixer and did not require any extra equipment in placing. The mixture was 1 cement to 2½ sand to 5 crushed rock to 2½ cobbles up to 6 in. The heavy section of this dam contained about 30 to 35 per cent of these cobbles, while at Arrowrock it was 27 per cent. Throughout the whole construction period labor was hard to get and hold. The contractor, the Shattuck-Edinger Co., expended $11,000 for procuring labor at the dam and $15,000 in the valley, or a total of $26,000 to Oct. 25. During construction a 6 x 8-ft. temporary opening through the dam was provided to carry the runoff, but the season of 1919 was the dryest of record and during much of the summer and fall the river was practically dry. The order in which the work was carried on and the progress per week are shown in the progress profile. The area marked 1 being carried on first while the trestle for 2 was erected. This first section contained the bypass and was constructed while there was still some flow in the river. While 2 was being deposited, the trestle was erected up to the full height over the first runway.

By months the yardage deposited was as follows: June, 3,372; July, 4,656; August, 4,583; September, 5,120; October, 1,608; and November, 73.

The construction of the dam was carried on at the same time as the work on the distribution system, both being under the direct charge of John H. Lewis, engineer-manager of the Warm Springs Irrigation District. A. J. Wiley, Boise, Idaho, was consulting engineer.



TRESTLE LEGS AS RIBS AND FORM SHEETS ON CONCRETE ARCH DAM

Professional Plagiarism
—*An Indictment*

By P. B. McDonald
Assistant Professor of English, College of Engineering, New York University

AMONG professional men the most persistent plagiarists are college graduates, and the barest-faced offenders of all are university professors. Men who have attended college seem to have absorbed the idea that writing a professional paper means procuring books on the subject and copying promiscuously; sometimes acknowledgment is made of the source, often it is not—especially it is likely not to be made when a deep or subtle idea is purloined, an idea that the originator perhaps labored for years to develop.

Perhaps the system that produces "doctors' theses" in our universities is responsible for the readiness with which unimaginative but laborious scholars help themselves to extracts from original sources, and, having added ponderous, vapid comments, publish the "dissertation" or "disquisition" as a monument to their own perspicacity. Frequently there is not a single original idea in a "doctor's thesis."

A writer in *Engineering Education* recently labeled such thefts "unconscious plagiarism." This writer was too amiable. When a national and ethical law is violated stupidly, why call the offender "unconscious"—stupidity is usually unconscious, even if college professors are the offenders. One of the worst cases of plagiarism on record was committed by a clergyman. He wrote a book on mathematics in which page after page was produced exactly as they had originally appeared in a work by a well-known professor of Columbia University, and no acknowledgment of the source was made. That the offender was a minister of the gospel no more condones the act than does a college education; the offense only seems the worse.

Engineers should be particularly careful not to plagiarize. If engineering ethics apply to anything, they apply to the professional acknowledgment of new ideas. Unfortunately, the devising mind frequently belongs to a modest dreamer who gets elbowed out of his due reward by a pushful fellow who steals the idea and stands on the loud pedal. Who really gave the mining industry the knowledge that is saving thousands of tons of metals by oil-flotation? No one seems to know, but a very hoggish British corporation (which certainly did not supply all the knowledge) is collecting the large royalties. Who invented the "tanks" used by the Allies in the War? A dispute has arisen in London over that very question. Such cases certainly do not show that the standard of engineering ethics is very high; they indicate that many minor injustices are occurring constantly, and that engineers are no more averse to stealing ideas than are clergymen and college professors.

How Some Books are Written

Plagiarism in engineering books is by no means uncommon. When an engineer writes a book disclosing some new idea or method, it is usually not long before several imitators have on the market books that are as similar as possible to the original work without actually copying it verbatim. The offended author and publisher dislike to start an expensive law-suit; and not infrequently the imitating has been so camouflaged that, though the author sees exactly how it was done, he would have difficulty in explaining the technicalities of the case to a judge or jury. What is needed is a stricter sense of what is right and just among professional men. An originator or inventor should be acknowledged and rewarded wherever it is possible to do so, even though he be an unknown underling or an eccentric amateur, and no pompous shouter should be allowed to defraud the man who deserves the reward.

Engineering and scientific societies in every part of the world should make special efforts to see that justice is done in apportioning credit for original ideas, and they should volunteer their services and records to assist the Government in awarding patents and copyrights. That an inventor is not a member of the particular society should make no difference in the energy with which the organization fights for fair play and professional justice. Many inventors belong to no society and lack influential friends. It is surprising to reckon up how many world-changing ideas have been developed in obscure garrets and private workshops; and it is even more surprising to consider how many of the inventors were never rewarded for their extraordinary work.

An Old Case

Of course, professional plagiarism is not new. Students of the history of science will recall the famous case of Cardan and Tartaglia, two rival professors of mathematics in Italy during the sixteenth centry. Tartaglia (The Stammerer) had discovered a solution of cubic equations of the form $x^3 + qx^2 = r$. Cardan, an exceedingly clever but unscrupulous astrologer, succeeded in worming the secret from Tartaglia, after swearing a solemn oath not to reveal it; he then published the solution as his own in his *Ars Magna* of 1545. In those days it was customary to keep scientific discoveries secret. Today a more generous spirit is current, but the old tendency to plagiarize still lingers. In the time of Pythagoras, a stricter code of ethics prevailed. Thus "Hippasus (W. W. R. Ball: *A Short History of Mathematics*, p. 20) is said to have been drowned by his fellow Pythagoreans about 470 B. C. for violating his oath by publicly boasting that he had added the dodecahedron to the number of regular solids enumerated by Pythagoras."

While mentioning classical scientists, an ancient opinion on a professional attitude of mind might be quoted as an explanation of plagiarism in all ages. Of Apollonius, "the great geometrician" of the first Alexandrian school, Pappus said he was "vain, jealous of the reputation of others, and ready to seize every opportunity to depreciate them." Human nature remains much the same after two thousand years. Plagiarism may be due partly to carelessness, but without doubt it is partly the result of professional jealousy.

Steaming Ties Increases Absorption

By preliminary steaming in the treatment of air-seasoned ties, according to specifications of the United States Railroad Administration in the Burnetting (zinc) and Card (zinc-creosote) processes, the absorption was materially increased over that obtained in regular previous practice. In red oak ties the increase was 12.6 per cent and in sap pine ties 52.2 per cent, according to figures presented at the recent meeting of the American Wood Preservers' Association by S. S. Watkins of the Watkins Creosoting Co.

Impounding Reservoir for Water Supply of Oklahoma City

Masonry Dam and Embankments, With Feed and Flood-Control Works, Spillways and Wasteway — Intake Conduit Through Dam

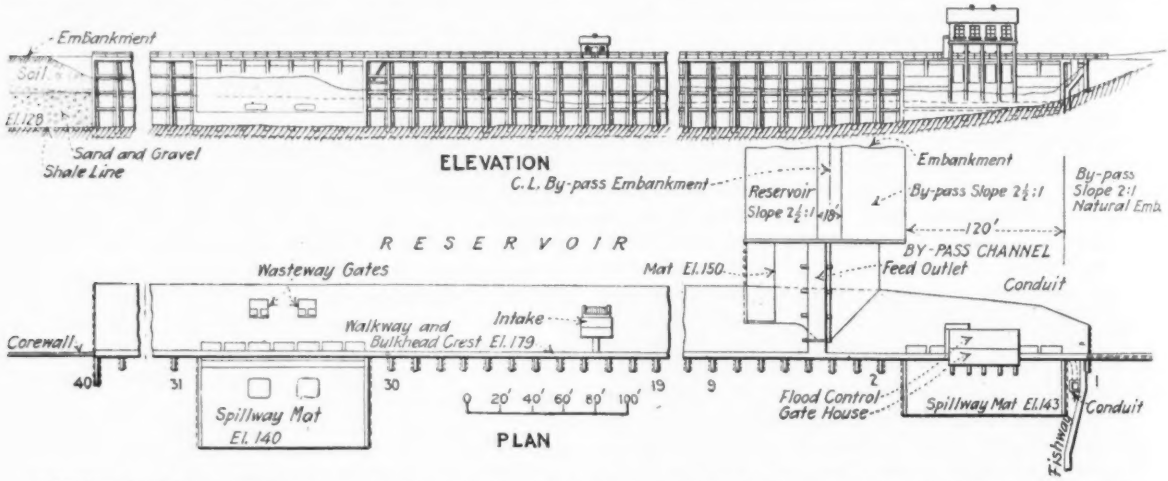
DEVELOPMENT of a natural basin as a storage reservoir, and provision of a channel to carry normal flow outside of this, but with automatic discharge of excess flood water through the reservoir, are the main elements in the design of the new works for a water-supply from the North Canadian River for Oklahoma City.

A dam closing the river channel forming the natural outlet of the basin creates a reservoir about 1½ x 2½ miles, covering 1700 acres, with from 8 to 26 ft. of water and having a capacity of about 7,000,000,000 gal. Above this and separated from it by the embankment built for an electric interurban railway is an extension of the basin having an area of about 800 acres and a capacity of 3,000,000,000 gal. From this basin a bypass channel extends parallel with the east side of the reservoir, being separated from it by an embankment and closed by the main dam, where gates are provided for regulating the flow. From the reservoir a 42-in. concrete conduit 7½ miles long, with a gravity flow of 21,000,000 gal. per day, extends to the filter plant just west of the city. This plant has a capacity of 8,000,000 gal. daily and includes a 20,000,000-gal. clear-water well from which the pumping engines take their supply. The conduit has elevations of 158 and 142.16 at the dam and filter plant, respectively.

Normally, the river flow will be through the bypass channel, at the end of which it will be diverted laterally into the lower end of the reservoir or discharged into a wasteway which enters the old river channel about 1200 ft. below the dam. In the upper end of the bypass embankment is a concrete dam serving as a spillway, so that in case of severe floods the water in the channel will flow over this emergency dam into the reservoir and escape over the spillway section of the main dam. As the winding condition of the river enables flood warning to be given two or three days before the flood reaches the reservoir, the gate operators would draw down the water in the reservoir by the wasteway culvert, if necessary, in advance of the flood.

The bypass channel, about 2½ miles long, has a bottom width of 120 ft., a depth of 20 ft. and a fall of 0.8 ft. per 5000 ft. Its upper end widens to 167 ft. at the intake, which is just above the railway embankment utilized as a diversion dam. This channel is separated from the reservoir by an earth embankment 18 ft. wide on top, with slopes of 1 on 5 for the reservoir side and 1 on 3½ for the channel side. At the upper end of this embankment is the emergency dam, which is a concrete structure 180 ft. long, built on a continuous mat or footing. In this is a gate 3 x 12 ft., with its longer side horizontal, the gate being made to open by lowering so that its upper edge forms the sill of the opening. This gate is provided mainly for the purpose of supplying water to the upper end of the reservoir, thus supplementing the main supply at the lower end and enabling circulation to be maintained.

The main feed gates from the channel to the reservoir are placed in a reinforced-concrete structure 100 ft. long, connected with and at right angles to the main dam and forming the end of the bypass embankment. In this are located four 4 x 6-ft. gates for regulating the supply to the reservoir.



LAYOUT OF NEW RESERVOIR AND CONTROLLING WORKS FOR WATER-SUPPLY OF OKLAHOMA CITY, OKLA.

Originally the river flowed from the lower end of the natural basin through an opening about 1100 ft. wide between the bluffs, which converge at this point. This outlet has been closed by the main dam, a concrete structure of the Ambursen hollow type, 1100 ft. long and about 53 ft. high, with a base width of 52 ft. It is built on a solid bed of shale, with a deep cutoff wall under the upstream toe and the east end extended as a core wall into the solid shale of the natural ground.

Its east end, closing the bypass channel, has a middle portion for the gates, flanked by two spillway sections. Four 9 x 12-ft. floodgates regulate the waste discharge from the channel and regulate the height of water in the channel while the reservoir is being filled through the feed gates already mentioned. At about midlength of the dam is the intake well, with three 42 x 42-in. sluice-gates for taking water at different levels. A 42-in. outlet conduit extends longitudinally from the well through the dam to an inspection well beyond the east abutment, from which the 42-in. conduit extends to the city. Near the west end of the dam is a 120-ft. spillway section, at the bottom of which are four 5 x 5-

ft. waste gates, provided mainly for sluicing out the silt, but they may be used to give additional discharge capacity.

The relations of these several parts may be seen from the following elevations: Crest of dam, 179 ft.; spillways at end of bypass, 174; spillway of main dam, 173; floodgate sills and bottom of bypass, 161; spillway on emergency dam, 176; crest of diversion dam, 185.

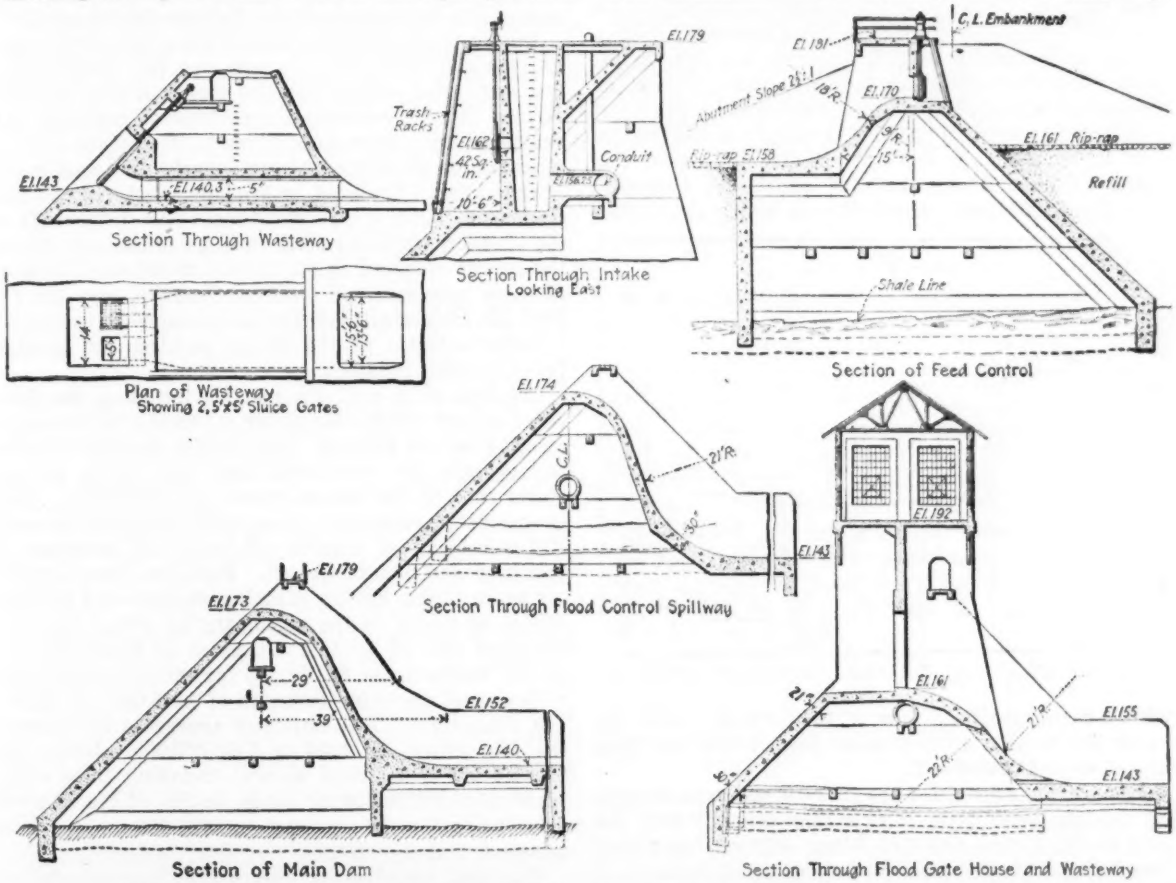
An earth embankment extends about 1000 ft. beyond the west end of the masonry dam. This has a concrete core wall with its top at the crest level and its bottom inclosing the top of a line of 30-ft. sheet piling driven 2 ft. into the shale, the surface of which is at about Elev. 128. The core wall is 18 in. thick at the top with a batter of 1 in 24 on both sides.

Flood capacity of the new works is a highly important element, in view of flood damages sustained by the city in the past, and it is considered that ample protection has been provided. The maximum flood record of the North Canadian River is 5200 sec.-ft. The capacity of the bypass channel, with 18 ft. of water and no discharge over the emergency dam into the reservoir, is about 6000 sec.-ft. With depths of 3 ft. and 5 ft. on the 180-ft. emergency dam, the respective discharge would be 5000 and 7000 sec.-ft. The four floodgates at the end of the channel give a combined discharge capacity of 8000 sec.-ft., while the two spillways on either side increase this to about 10,700 sec.-ft. The reservoir spillway has a capacity of 5000 sec.-ft. while the four waste gates will discharge a total of 2700 sec.-ft. under 33-ft. head. Thus, the bypass and the reservoir have each a discharge capacity considerably in excess of the maximum flood records of the past.

Incidental works are a fishway at the east side of the bypass and an earth embankment on the south and west sides of the reservoir to raise the water to the desired elevation. The embankments are similar to that of the bypass channel.

These works were designed in 1915 by the late Guy V. McClure, then city engineer, the design being based upon a report made several years ago by the late Andrew Rosewater. H. A. Pressey was consulting engineer and H. M. Nabstedt was resident engineer. In 1911 a bond issue for a similar proposition was defeated, largely due to strong but ill informed opposition on the part of the state health authorities, who feared sewage pollution from a town 100 miles upstream and advocated sewage treatment rather than water purification. In 1916 the bond issue of $1,500,000 was passed by a large, favorable vote. These conditions were noted in *Engineering News* of Mar. 2, 1911, p. 267, and June 22, 1916, p. 1198.

The dam and reservoir works and the conduit to the city were completed in 1919. The filtration plant was completed in 1909. The city has a population of about 110,000, with a daily water consumption of about 10,000,000 gal., or 90 gal. per capita. The new works are designed to provide 120 gal. per capita per day for a population of 175,000. The minimum record of annual flow in the river is 42,177,000,000 gal. for 1905.

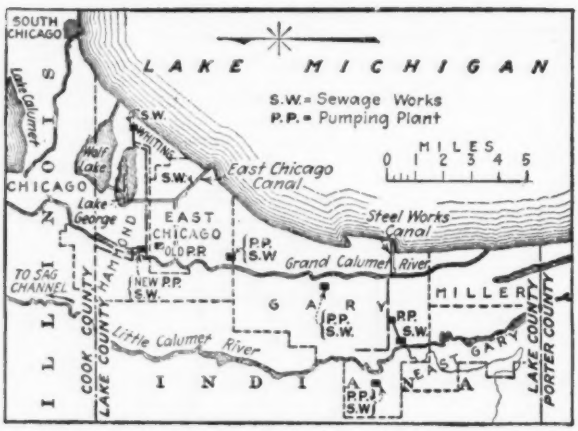


MAIN DAM WITH INTAKE, FLOOD CONTROL AND FEED CONTROL FROM BYPASS CHANNEL

Joint Sewage Disposal of Indiana Lake Cities

Calumet Sanitary District, Including Four Cities, Would Have Seven Treating Plants Under Unit Control

SEVEN sewage-works for Gary, Hammond, East Chicago and Whiting, Ind., together with the creation of a sanitary district to include these cities and to build and operate the sewage-works, constitute the best solution of the water-protection and sewage-disposal problems of this group of cities, according to the recent report of a board of engineers. The aggregate population is estimated at 166,200 for 1919 and 494,000 for 1940. The four cities are in the Calumet district on the Indiana-Illinois boundary, the topography being flat and the soil sandy. This district comprises the greater part of the drainage areas of the Grand Calumet and Little Calumet Rivers, both of which are connected with Lake Michigan. The former is a sluggish stream



MAP OF PROPOSED CALUMET SANITARY DISTRICT

with a maximum flood flow of 1450 sec.-ft., while the latter varies from a dry-weather flow of 200 to a flood flow of over 13,000-sec.-ft.

Each of the four cities has its own sewerage system, of the combined type, discharging directly into the lake or the Grand Calumet River, without treatment. The Little Calumet receives only a small amount of sewage, but the Grand Calumet is so heavily polluted with domestic and industrial sewage as to be a serious nuisance, besides causing pollution of Lake Michigan, from which all of the cities take their water-supply. The supply of the City of Chicago is also affected through its 68th St. intake. The dangerous condition is indicated, says the report, by the fact that the typhoid-fever death rates are far in excess of the Chicago rate, while the Calumet section of Indiana is largely responsible for keeping alive the typhoid infection in northern Indiana and in Illinois. Industrial wastes will add to the pollution but are not covered by the report, which deals only with sewage.

Filtration alone might produce a safe drinking water, but still the water-supply would be subject to gross pollution by the storm discharge of the Grand Calumet River. To discharge all the sewage into the rivers would increase the nuisance and continue the danger of lake pollution in time of flood discharge. Dilution by discharge of the sewage into the Calumet-Sag channel, now being built by the Sanitary District of Chicago to connect the Little Calumet River with the Chicago Drainage Canal, is not practicable, since the entire flow of this channel will be required for diluting the sewage of the district. It is the conclusion of the engineers that the remedy must not only remove the local nuisance but must also greatly reduce the danger of lake pollution without imposing upon works in Illinois any burden for dilution. The treatment must produce a stable effluent which requires no dilution and contains sufficient oxygen for its own purification. The comparatively small volume of effluent could be cared for in the flow of the two rivers to the Calumet-Sag channel.

Two methods available to meet the requirements are: (1) the activated-sludge process and (2) Imhoff tanks and sprinkling filters, but the report states that the former is still somewhat experimental, although its principles are known to be correct. Its details require considerable development, particularly for such weak sewage as that produced by Whiting, East Chicago and Hammond. Only a careful estimate will show which is the cheaper, while the choice will be influenced also by the results obtained in plants now under way. Either of these processes will work successfully, says the report, but the activated-sludge process appears to furnish a better solution of the sludge problem and greater freedom from nuisance.

Creation of a sanitary district including the four cities is now practicable under a recent amendment to existing laws of Indiana. The district would plan, build and operate the works and keep them up to the requirements of the future growth of population. This is considered preferable to separate teratment by each city, especially as regards efficiency and economy of operation and administration. Tentative plans provide for seven plants having pumping stations and sewage-works, as shown on the accompanying plan. The construction cost to 1925 is estimated at $2,628,260 for partial treatment or $5,004,480 for complete treatment, with annual operating expenses of $340,000 and $526,-440, respectively. The estimated aggregate valuation of the four cities for 1920 is $306,000,000. Under the present law a drainage district including these cities could raise $6,120,000 by bonds, or 2% of the assessed valuation, and make a tax levy of $765,000 for operating expenses, and interest.

The joint board of engineers that has reported on this project consists of William F. Bridge, city engineer of Hammond; W. M. Cottingham, city engineer of Gary; Lloyd Smith, city engineer of Whiting; Charles K. Wallace, city engineer of East Chicago; Langdon Pearse, sanitary engineer of the Sanitary District of Chicago, and G. M. Wisner, chief engineer of the Sanitary District of Chicago.

Bhakra Dam to Have Height of 395 Feet

The Bhakra Dam, which it is proposed to build across the Sutlej River, India, in the Bhakra Gorge, some 40 miles above Rupar, the headworks of the existing Sirhind Canal, will be, says the *Madras Mail*, 395 ft. high from foundation level to roadway, and will be the highest dam in the world. The depth of water in front of the dam will be about 375 ft., good rock for the foundation having been found near the surface. The length of the top of the dam will be 1,015 ft. The water to be stored by the dam in the month of August annually will be 2,500,000 acre-feet.

Heavy Construction on San Diego and Arizona Railway

Involved Twenty-One Tunnels Aggregating 15,000 Feet — Special Roads Built for Motor Trucking Equipment to Portals

HEAVY tunnel construction, for which roads through rough mountain country were especially built for hauling equipment by motor truck, was encountered in building the recently completed line of the San Diego & Arizona Railway Co. between San Diego, Cal., and El Centro in the Imperial Valley, connecting with the line of the Southern Pacific Co. There are 21 tunnels on the line, aggregating 15,207 ft., of which 17 are in the Carriso Gorge. A description of the location of the line appeared in *Engineering News-Record* of Aug. 22, 1918, p. 365.

The accompanying photograph, showing the grade of the line through Carriso Pass with a tunnel portal in the foreground, is characteristic of the type of construction encountered. The plank road, in the foreground, connecting the tunnel portals, was graded and built specially for delivering materials and equipment.

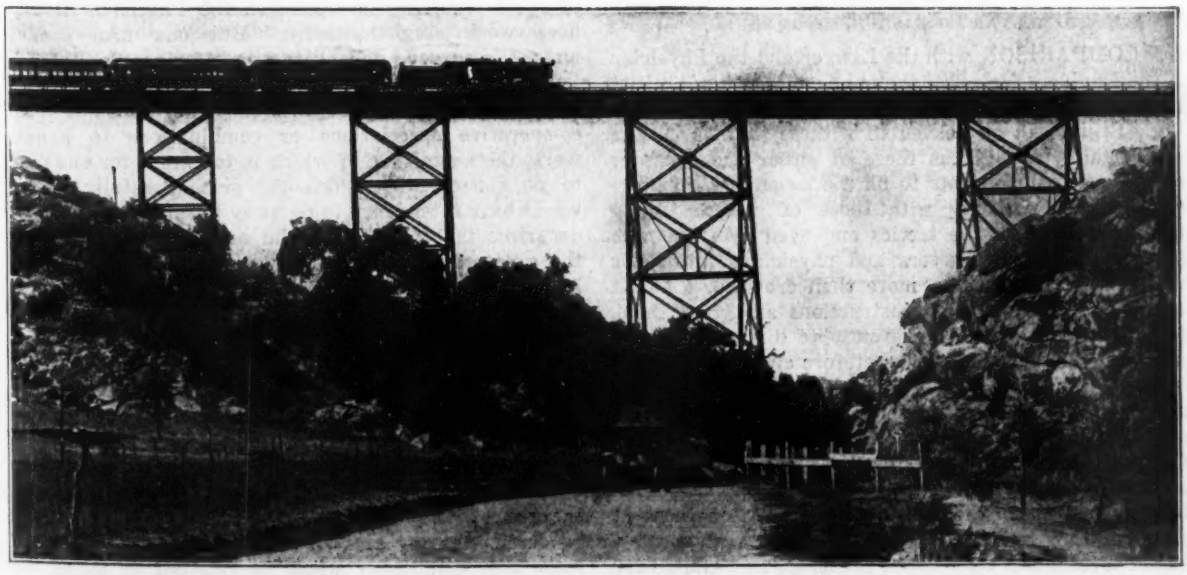
On the Mexican portion of the line tunnels were constructed with concrete portals with from 25 to 50 ft. of concrete lining at each end, the intermediate portion being lined with redwood timber where necessary. For most of the tunneling, which is in United States territory, timber portals an d timber lining were used exclusively. Typical construction is indicated in the photograph showing underheading in one of the shorter tunnels on Carriso Pass.

Wooden trestling on the line is principally of the ballast deck type, with asphalt covering, the structures consisting of five pile bents or five post frames resting on mud sills. In cases where there is possibility of washouts, which might make necessary a change of location, temporary framed or pile structures of the open-deck type of untreated pine are used.

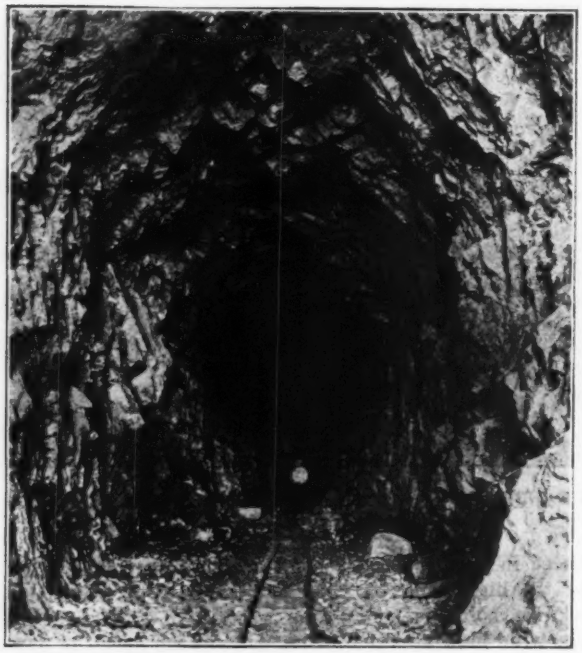
The largesst structure on the line is the viaduct at Campo Creek, 580 ft. long and 175 ft. high, shown in the photograph. Considerable difficulty was experienced in placing the girders of this viaduct on account of the high winds in the Laguna range of mountains at this point. During the erection of the structure the wind blew almost continuously up the gorge in daylight hours, making it difficult to handle the steel and hindering all work that had to be done off the ground. This delay, chargeable to wind, trebled the construction period, according to railroad officials, who said that had it not been for the wind the job, which took six months could have been finished in sixty days.

TUNNEL CONSTRUCTION REQUIRED SPECIAL ROADS TO BE BUILT FOR HAULING EQUIPMENT

The most trouble was encountered in placing the long girders. The wind was strongest, of course, where the center girders were to be set. These were 100 ft. long and 9 ft. deep, and when swung free in the wind became almost unmanageable. They were handled by a locomotive crane rigged up temporarily with a 60-ft. boom, reinforced with cables. Tackles were attached to each end of the girders to hold them steady in the wind, but they could not be guided at all on some days, and there were many unsuccessful attempts before the two longest girders were satisfactorily set. When



VIADUCT AT CAMPO CREEK



UNDERHEADING IN TUNNEL NO. 9, CARRISO GORGE

they were finally in place three hundred hours' time had been charged against the locomotive serving the girder crane. Under favorable conditions, it is estimated, forty or fifty hours should have been sufficient for this item.

The line was constructed under the direction of D. W. Pontius, general manager, and E. J. Kallright, chief engineer.

Suggested Remedies for Some Ills of the Engineer

Apply Law of Supply and Demand—Private Practice in Groups of Specialists for All Corporation Work

By S. M. Swaab
Mem. Am. Soc. C. E., Philadelphia.

IN COMPARISON with the Lawyer and the Physician the Engineer feels that the public slights him because it apparently does not accord him the same high standing. Still I call on heaven to witness that our ethics are certainly as high as those of either and that our educational requirements to fill the larger positions are certainly on a parity with those of either. Being unacquainted with the tactics employed by those who successfully launch lawyers and physicians into fields which seem at all times more than crowded, I am at a loss to know just what instructions are given them, if any, to enable them apparently to discount the elements of the economic law heretofore cited. One thing, however, that we notice is that lawyers and physicians, after some competent authority has designated them as being able to perform certain functions for which there is a market, immediately hang out their shingles and wait for clients or patients. Then, encouraged by the fact that "there is always plenty of room at the top," they seemingly leave to fate the rest—professional success and commercial prosperity. Usually they have to wait a long time for success, if it ever comes; but when it does come, it is the result of efforts of the individual. Also all of the benefits of success go to the individual.

Now, what we must consider is whether or not a similar disposition of the services of the Engineer is possible. It is certainly a fact that if every engineer, at the beginning of his career, were to set himself up in business there would eventually be created a shortage of engineers and engineer-assistants hireable by the industrial and public service corporations. It might be an uphill job for the vast majority, and many of us might feel the pangs of hunger and some possibly might fall by the wayside before the object were attained; but eventually we would bring about the condition we are seeking—that the Engineer may be deemed "worthy of his hire."

It may be argued that the Engineer is unfitted at the start to practice independently, and doubtless this is true to a large extent. But it is likewise true of the Lawyer and the Physician, and in emulation, our case may properly resolve itself into a system of our indenturing ourselves to engineers of recognized standing for a given time, as was the custom many years ago in this country and in England Thence we could graduate into private practice. Such graduation could be timed by the date of recognized eligibility for membership of the associate grade in one of the four national societies. This would be comparable with the Lawyer's post-graduate service in the office of a law concern of standing and with the hospital internship of the Physician which enable them to secure some practical knowledge of their art before applying it on their own hook.

The work of the Lawyer, the Physician and the Engineer are, however, not entirely analogous. In the case of the first two they work, or can work, individually, while in the case of the last team-work is always required to accomplish anything. One individual can work up a case for trial and actually try the case in court. One man can, although it is not usual, diagnose a case, prepare the person for operation, administer the anesthetic, perform the operation and render the subsequent treatment. In the vast majority of cases requiring no operation the Physician usually does work single-handedly. But one man cannot make the surveys and all the multifarious designs for industrial and utility structures. This will require co-operation among engineers. They should form co-operative associations or combinations to handle work, the magnitude of which is too great for one man to do conveniently, efficiently or successfully. This would have a tendency to do away with the engineering departments of our industrial establishments wherein the greatest crimes of underpayment are perpetrated. It is there the young Engineer, usually working as a draftsman and in many instances subordinated to others who have little sympathy with him and his work, is relegated to the status of a machine, particularly after thorough standardization of the work is accomplished.

When the industries and others now employing engineers, who usually consider their engineering departments necessary evils, are required to go out into the market and have their work done in private offices, there will be a more substantial return for the services rendered. In any case an engineering organization of some kind doubtlessly would be retained by all of the corporations requiring engineering services. Still it is

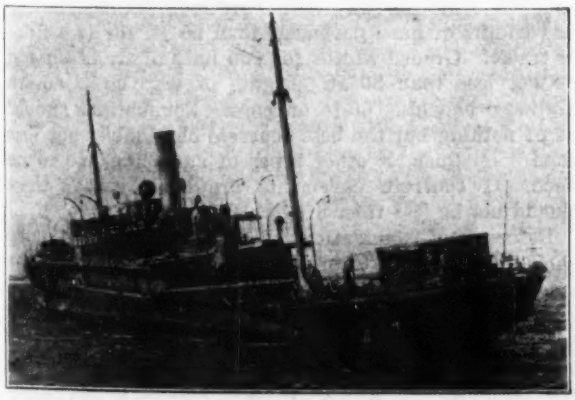
conceivable that a condition can be brought about whereby the preliminary outlining of a scheme or a roughing out of the general features of a given piece of work may be done in the office of the concern, and the actual design and subsequent construction carried out by engineers in private practice.

Concrete Ship "Polias" on Rocks Off Maine Coast

Hull Is Ripped Open on Side from Stem to Stern, But Frame Is Undamaged—Attempted Salvage Not Yet Decided

DURING the blizzard which raged in the northeastern part of the country the first week of February the concrete ship "Polias," built by the United States Emergency Fleet Corporation, went ashore on the rocks off the Maine coast about 20 miles southeast of Rockland. The ship lies at a relatively inaccessible place, about 5 miles from mainland and about 2 miles from a coast guard station on Burnt Island. It has not been possible up to now, therefore, to get any report on the condition of the boat, but representatives of the United States Shipping Board, after spending over a week at the coast guard station, have been able to get to the ship a sufficient number of times to make a thorough inspection. Their report in detail will be made to the Shipping Board, but from one of them, Lewis R. Ferguson, of the engineering firm of Wig, Hollister & Ferguson of Philadelphia, the following description of the ship's condition has been obtained. Mr. Ferguson was retained by the Government to inspect the condition of the ship structure. During the war he was general manager of the Liberty Shipbuilding Co., which built three concrete ships for the Government at Wilmington, N. C., and at Brunswick, Ga. He was not connected with the design or construction of the "Polias."

The "Polias" was built on Flushing Bay, Long Island, during the summer and fall of 1918. It was described in *Engineering News-Record*, Dec. 12, 1918, p. 1058, although at that time it had not received its name, so the word "Polias" does not appear in that article. The ship was built under the general superintendence of the Fougner Concrete Shipbuilding Co. after designs made by the company which were revised and approved by the Concrete Ship Section of the Emergency Fleet Corporation. It was launched May 22, 1919, and put into service late in the same year. It had made one or two trips up and down the Atlantic Coast.



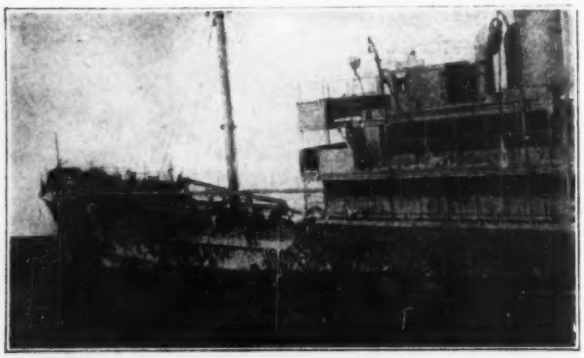
CONCRETE SHIP "POLIAS" ON ROCKS OFF COAST OF MAINE

SHIP IS NOT MOVING: MEN CAN STAND AND WORK ON DECK

The ship had a designed dead-weight carrying capacity of 3,500 tons. The Emergency Fleet Corporation has recently reported that its actual deadweight carrying capacity is about 2,500 tons. It is 281 ft. 9 in. long, 46 ft. beam and 26½ ft. molded depth. It had heavy transverse frames spaced 4 ft. on centers, a center and two side keelsons, four bulkheads, one fore, one aft and two inclosing the engine and boiler room. The deck is carried by two continuous girders forming the hatch coamings and is supported by widely spaced concrete pillars made of heavy iron pipe with flanged heels and heads. In general the bottom and side shells are 5 in. thick and the side shell reinforcement consists of two layers of diagonally placed reinforcement of ½-in. and ⅝-in. square deformed bars. The deck varies somewhat with an average thickness of 4½ in. At 6 ft. above the water line a horizontal bilge girder is carried all around the ship, running flush with the tank top slab. The floorbeams and the frames are in general 8 in. thick, except in the tank top section where they are 5 to 6 in. The ship was built according to the usual methods of the Government in concrete ship work, using gravel aggregates. It was not possible at the time the concrete was poured to obtain the light weight aggregate used on the other Government ships. It was, however, different from the other ships in that the outside half-inch of the hull above the bilge curve was placed by cement gun after the main concrete shell had been poured in the usual manner.

Details regarding the wrecking of the ship are not altogether clear. The ship was southbound to Norfolk after having delivered a cargo of coal to one of the Maine ports. It was running light except for its own coal. Snow was falling on the afternoon of Feb. 6 when the boat was off Penobscot Bay and the captain was running by compass and charts. The rock, known as Cilley Ledge on which the ship grounded is charted, though not prominent enough to be easily seen in heavy weather. It seems probable at present that some miscalculation of the speed of the boat was made and that the course was not changed in time to avoid the rock. At the time the boat hit it was running at full speed somewhere between 9½ and 10 knots.

The ship ran on the rock about five o'clock in the afternoon. Eleven men, including three subofficers, against the direct orders of the captain left immediately in a light boat. They have never been heard from since



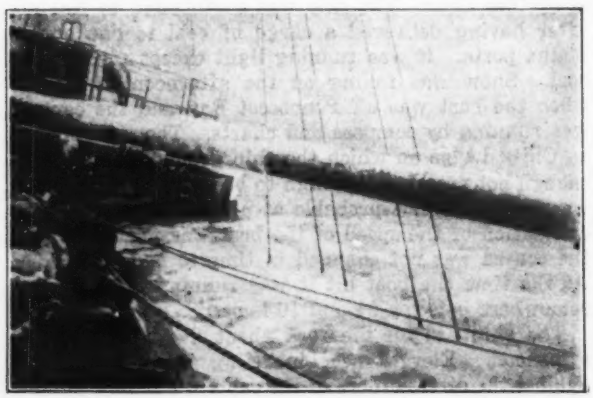
STERN OF "POLIAS" UP ON SHELVING ROCK IN 10 FT. OF WATER AND 11 FT. OF TIDE

nor has there been any trace of their boat or bodies. The remainder of the crew, some thirty men, stayed on the boat until the next day, when they were taken off by the coast guard from the nearby island. At that time the sea was calm enough so that the men were able to take with them all of their personal belongings. The ship at present, therefore, contains nothing except its own boiler coal.

The ship is lying stern on a shelving rock. At low water the stern is in about 11 ft. of water and the bow is nearly under water. There is about 10 ft. tide. The ship is canted at an angle of 7½ degrees from the vertical. On account of the depth of water in which the boat lies it is impossible to make an examination of her hull except by diver and the government party contained diving equipment and a man experienced in such work. It was possible, therefore, to make in one or two days of very still water a complete examination of the hull.

The ship apparently ran between a line of jagged rocks in grounding, for her hull is ripped open on both sides practically the whole length of the ship, the opening varying from 2 to 7 ft. In consequence the boat is entirely filled with water, except for the stern tank which is dry. Examination by the diver showed, however, that the break in the side is confined practically entirely to the shell, except where rods have torn a small part of the frames. The frames themselves in the main are intact. So far as examination goes, too, the keelsons and the bottom of the ship are not damaged.

A careful examination of the above water part of the ship shows no damage to the framework. The ship has not hogged nor sagged, as there are no cracks in the deck or the longitudinal frames that can be seen. The cement gun finish is in very good shape and in no place has left the concrete of the hull itself.



SEAS WASHING ABOARD AMIDSHIP AT HIGH TIDE

A remarkable thing about the wreck is that the ship apparently has not moved since it struck. There is absolutely no pounding going on at present. Small readily movable articles, such as medicine bottles on a table, left on the ship one day were found standing unmoved two or three days later after the ship has been subjected to a heavy storm. All evidence points to the fact that there is no racking going on.

No official statement is now available as to the prospects of salvaging the vessel. Several plans have been prepared which promise successful results, but they will have to be submitted to the Government before they can be made public. In the main, however, it is felt by those who examined the ship that it is in remarkable condition considering the severe shock which it received and that the chances for its recovery are fair.

Main Roads Must Be Designed for Freight Traffic

DIFFERENTIATION between light and heavy motor-truck traffic can no longer be safely practiced in designing highways, states W. G. Thompson, state highway engineer of New Jersey. In a paper presented Nov. 7, 1919, before the North Atlantic Division of the National Highway Traffic Association, Mr. Thompson announces it to be his conviction that except in isolated rural districts, no road should be designed with a view to its being used solely by light motor vehicles.

In the agricultural sections of New Jersey, five years ago, the farmers supplying the Philadelphia markets and the large canning industries in Camden were accustomed to load possibly one or two tons of produce into wagons in the afternoon, and start between midnight and 2 or 3 a.m., in order to deliver fresh produce to the city market each morning. The advent of the smooth, hard pavement and motor truck has brought about a radical change in transportation of this produce. Hundreds of farmers now load from two to four tons on trucks and make two or three trips in the same time formerly consumed in making one trip with one or two-ton loads.

Experience, and observation of conditions, lead to the conviction that no interurban highways should hereafter be built in the Middle and North Atlantic States between Norfolk, Va., and Portland, Maine, having less widths of hard pavement than 20 ft. for two lines of traffic. Graded widths for two lines of traffic should be not less than 30 ft. Rights of way on all main highways should be 60 ft. or more. Foundations should be of nothing but the best concrete obtainable, not less than 8 in. thick, if other types of surfacing are to be used. If concrete pavements are to be used, they should not be less than 8 in. thick.

Before any foundation is laid, painstaking care should be exercised to provide adequate and permanent sub-foundation drainage facilities. The greatest length of visibility possible should be obtained on curves. The tremendous increase in gasoline consumption makes it especially desirable and necessary to reduce grades to the minimum. Highway bridges should be designed for not less than 20-ton loading, assuming that 75 per cent of the load is carried on the rear axle.

LETTERS TO THE EDITOR

Comment on Matters of Interest to Engineers and Contractors Will Be Welcome

Adrift From Its Traditions?

Sir—There are times when non-constructive criticism may be well warranted. The observation is prompted by your editorial of Feb. 26 on the circular, "A Word of Warning," recently sent to the membership of the American Society of Civil Engineers by one hundred and six of its members in various parts of the country.

Question 3 of the society's questionnaire, on which the circular strongly urges members to vote "no," calls for the acceptance or rejection, as a whole, of the joint conference committee's proposal for a general welfare council of engineering and allied technical associations, according to a scheme which many, after careful study, consider radically unsound. A vote "yes" or "no" is specifically required, without other option. No alternative plan is offered for voting. Before a better plan can be formulated and put to vote, this one must be defeated. Constructive criticism, which, if given opportunity, ought to result in bringing forward a satisfactory plan, finds no application at this juncture. The only useful present course, for those who recognize the dangers to the society in the proposed scheme, is to point out its unsafe features, and that is just what the circular is intended to do. FREDERICK C. NOBLE.

New York.

Sir—In its editorial on the circular, "A Word of Warning," *Engineering News-Record* states that the circular does not face the issue of whether it is necessary to participate in efforts to improve the status of the engineer.

We point out that the circular does record the view that the American Society of Civil Engineers should do professional welfare work in any manner proper and practical. Along non-technical lines the efforts of the engineers should be to effect solidarity of the profession as a whole. To this end there is required much more thorough-going preparatory work than that of the Joint Committee.

We should realize that the work of the American Association of Engineers has already assumed substantial proportions, and we should seek to find out what the future is likely to bring forth from this new organization, which proposes to spend for welfare work $10 per member per year as constrasted with $1.50 in the comprehensive organization proposed by the committee.

Real solidarity is needed and real progress will come more quickly if we face squarely the American Association of Engineers and other preparatory questions rather than allow to be railroaded into existence a program which is not as comprehensive as its name implies. GEORGE W. FULLER.

Sir—Your editorial, "Adrift From Its Traditions," in the *Engineering News-Record* of Feb. 26 raises a question as to the position taken in a circular letter recently sent to the membership of the American Society of Civil Engineers.

The question as you present it is as to the discharge of his civic responsibility by the engineer. As an individual, the engineer does have a civic responsibility. He is bound to be a good citizen, and do all that a good citizen should do; and his special knowledge and skill give him increased opportunities, and with these he must accept increased responsibility.

But when it comes to a question of an engineering society taking action on public questions, that is another matter.

When it comes to maintaining an office or organization that is engaged in promoting, opposing or "supervising" proposed legislation, municipal, state and national, it is perfectly clear that a technical society cannot wisely do things of this kind. To do it is incompatible with the purpose of the society, and if such things are done, in my judgment it can only result in weakening, if it does not, in fact, destroy the technical work of the society. Even in the comparatively simple case of a local society taking part in the municipal problems of the city in which the local society is located, it is my observation that such action practically results in the substitution of the general view of the membership, which general view is essentially superficial and usually not well founded, for the sound professional consideration on which the discussion of important municipal problems should rest. It is my belief, based on observation, that when such local societies pass resolutions upon municipal problems, as a rule more harm than good results.

No doubt some things can be done, especially in seeing that competent engineers are employed to study important problems, but even in this, individual effort and individual protest would seem to be more fitting and, perhaps, also more effective than society action intended to bring pressure as a result of the combined influence of all the engineers.

In the case now before us we are voting on a proposition to divert 10 per cent of the society's income to be used by bodies not under control of the society, or its officers, and in whose procedure we have no voice beyond the slight proposed representation. And it is proposed that this money is to be used for the purpose of making us an active force in economic, industrial and civic affairs.

It is my opinion that we can make ourselves a force as individuals, but not as a society, or as a group of societies, and I object to lending support to projects of this kind to be undertaken by the society directly, and still more to the proposal to turn over 10 per cent of its income to an outside organization to be spent for no one knows what propaganda. ALLEN HAZEN.

New York.

Not Responsible for Elevator Foundations

Sir—At the close of the article "Foundation Troubles of Portland City Grain Elevator," in your issue of Jan. 22, 1920, p. 179, it is stated that the elevator was designed by Witherspoon-Englar & Co., elevator engineers, of Chicago.

We feel that this statement is misleading to the profession at large, as it can easily be assumed that we were responsible for the design and supervision of the construction of faulty pile foundations. This is not the case, however, as the pile foundations were designed by the Commission of Public Docks at Portland. The

piling was driven under a separate contract according to the specifications prepared by the Commission of Public Docks and were specifically excluded on a statement of costs rendered by the commission on which we received compensation for engineering service. Furthermore, our commission for engineering services covered only design and we had no part in the engineering supervision of the driving of these piles.

A. M. CRAIN,
Chicago, Ill. Vice-President Witherspoon-Englar Co.

Conversion Table for Plotting Curves

Sir—The accompanying table was prepared to simplify the use of drafting curves used in plotting up track layouts, since the curves in common use are practically all of the 1 in. = 100 ft. scale, and in the use of other scales it is necessary to reduce a curve by calculation. Although this calculation is simple, there is a chance for errors and a certain loss of time is involved which has been found to amount to about 15 per cent of lost time.

As an illustration, the table is used as follows: To plot an 8 deg. curve on 1 in. = 30 ft. scale the draftsman will find the curve indicated in the column headed 1 in. = 30 ft. opposite 8 deg. in the column headed Degree of Curve and it will be found to be a 2 deg. and 24 min. curve, radius 2387.5 ft. If his templets are marked with degrees he will select the nearest curve to 2 deg. 24 min., which would be 2 deg. 30 min. If the templets are marked by numbers indicating radii, he will select the templet marked with the number 24, indicating that it is on a 24-in. radius and which, on a 100-ft. scale, would be equivalent to 2,400 ft., the nearest distance to the radius of 2387.5 ft.

J. G. WALSH,
Chief Field Engineer Tennessee Coal, Iron and Railroad Co.
Ensley, Ala.

Improper Drainage and Highway Failures

Sir—After being called an "arm-chair wonder" and many other things other than pleasant, implied by Mr. Hirst because of my article on highways, published in your issue of March 21, 1918, p. 543, it is rather pleasant to read the captions of highway articles appearing in your journal from time to time, particularly in the Feb. 5, 1920, number. A few of these captions are: "Iowa Has Thousands of Miles of Road Ready, Prepared for Hard Surfacing"; "Variable Designs for County Highway Systems"; "Care in Laying Foundation and in Compacting Base Underlie Efficient Service"; Heavy Traffic Road Design Places Stress on Drainage," etc.

If highway engineers will use the article mentioned as a textbook and keep a copy of it at their elbows they may find some more valuable directions anent road maintenance and building besides those covered by the above captions.

Not one word of favorable comment have I yet heard from a highway engineer, nor the intimation of a desire to discuss road matters, but "imitation is the sincerest form of flattery," so I must be content with watching the attempts at imitation. A. A. YOUNG.
Jewett City, Conn.

Building Highways for Heavier Loads

Sir—In the Jan. 15 issue of *Engineering News-Record*, p. 149, George H. Pride, owner of the Heavy Haulage Co., calls attention to the abuse of the highways by overloading trucks, and offers a remedy for this through rigid loading laws. This suggestion coming as it does from a truck operator is surprising and certainly shows a commendable spirit of fairness on his part, but I do not believe the problem will ever be solved by such laws.

In the first place, it is contrary to the spirit and needs of the times. We are in the midst of an era of great transportation needs and anything which tends

TABLE FOR CONVERTING FROM SCALE OF 1 IN. = 100 FT. IN PLOTTING CURVES

1 In. = 100 Ft.			1 In. = 60 Ft.			1 In. = 50 Ft.			1 In. = 40 Ft.			1 In. = 30 Ft.			1 In. = 20 Ft.			1 In. = 10 Ft.		
D.C. Deg.	Deg.	R.	D.C. Deg.	Min.	R.	D.C. Deg.	Min.	R.	D.C. Deg.	Min.	R.	D.C. Deg.	Min.	R.	D.C. Deg.	Min.	R.	D.C. Deg.	Min.	R.
1	1	5,729.6	0	36	9,549.3	0	30	11,459.2	0	24	14,323.6	0	18	19,098.6	0	12	28,647.8	0	06	57,295.8
2	2	2,864.9	1	12	4,774.7	1	0	5,729.6	0	48	7,162.0	0	36	9,549.3	0	24	14,323.6	0	12	28,647.8
3	3	1,910.0	1	48	3,183.2	1	30	3,819.8	1	12	4,774.7	0	54	6,366.3	0	36	9,549.3	0	18	19,098.6
4	4	1,432.6	2	24	2,387.5	2	0	2,864.9	1	36	3,581.1	1	12	4,774.7	0	48	7,162.0	0	24	14,323.6
5	5	1,146.3	3	0	1,910.1	2	30	2,292.0	2	0	2,864.9	1	30	3,819.8	1	0	5,729.6	0	30	11,459.2
6	6	955.4	3	36	1,591.8	3	0	1,910.1	2	24	2,387.5	1	48	3,183.2	1	12	4,774.7	0	36	9,549.3
7	7	819.0	4	12	1,364.5	3	30	1,637.3	2	48	2,046.5	2	06	2,728.5	1	24	4,092.7	0	42	8,185.2
8	8	716.7	4	48	1,194.0	4	0	1,432.7	3	12	1,790.7	2	24	2,387.5	1	36	3,581.1	0	48	7,162.0
9	9	637.3	5	24	1,061.4	4	30	1,273.6	3	36	1,591.8	2	42	2,122.3	1	48	3,183.2	0	54	6,366.3
10	10	573.6	6	0	955.4	5	0	1,146.3	4	0	1,432.6	3	0	1,910.1	2	0	2,864.9	1	0	5,729.6
11	11	521.6	6	36	868.6	5	30	1,042.1	4	24	1,302.5	3	18	1,736.5	2	12	2,604.5	1	06	5,208.8
12	12	478.3	7	12	796.3	6	0	955.4	4	48	1,194.0	3	36	1,591.8	2	24	2,387.5	1	12	4,774.7
13	13	441.6	7	48	735.1	6	30	881.9	5	12	1,102.2	3	54	1,469.4	2	36	2,203.9	1	18	4,407.5
14	14	410.3	8	24	682.7	7	0	819.0	5	36	1,023.6	4	12	1,364.5	2	48	2,046.5	1	24	4,092.7
15	15	383.1	9	0	637.3	7	30	764.7	6	0	955.4	4	30	1,273.6	3	0	1,910.1	1	30	3,819.8
16	16	359.3	9	36	597.5	8	0	716.8	6	24	895.7	4	48	1,194.0	3	12	1,790.7	1	36	3,581.1
17	17	338.3	10	12	562.4	8	30	674.7	6	48	843.1	5	06	1,123.8	3	24	1,685.4	1	42	3,370.5
18	18	319.6	10	48	531.3	9	0	637.3	7	12	796.3	5	24	1,061.4	3	36	1,591.8	1	48	3,183.2
19	19	302.9	11	24	503.4	9	30	603.8	7	36	754.4	5	42	1,005.6	3	48	1,508.1	1	54	3,015.7
20	20	287.9	12	0	478.3	10	0	573.7	8	0	716.7	6	0	955.4	4	00	1,437.7	2	0	2,864.9
21	21	274.4	12	36	455.6	10	30	546.4	8	24	682.7	6	18	909.5	4	12	1,364.5	2	06	2,728.5
22	22	262.0	13	12	435.0	11	0	521.7	8	48	651.7	6	36	868.6	4	24	1,302.5	2	12	2,604.5
23	23	250.8	13	48	416.2	11	30	499.1	9	12	623.5	6	54	830.8	4	36	1,246.0	2	18	2,491.3
24	24	240.5	14	24	398.9	12	0	478.3	9	36	597.5	7	12	796.3	4	48	1,194.0	2	24	2,387.5
25	25	231.0	15	0	383.1	12	30	459.3	10	0	573.6	7	30	764.5	5	0	1,146.3	2	30	2,292.0
26	26	222.3	15	36	368.4	13	0	441.7	10	24	551.7	7	48	735.1	5	12	1,102.2	2	36	2,203.9
27	27	214.2	16	12	354.9	13	30	425.4	10	48	531.3	8	06	707.9	5	24	1,061.4	2	42	2,122.3
28	28	206.7	16	48	342.3	14	0	410.3	11	12	512.4	8	24	682.7	5	36	1,023.6	2	48	2,046.5
29	29	199.7	17	24	330.6	14	30	396.2	11	36	494.8	8	42	659.2	5	48	988.3	2	54	1,975.9
30	30	193.2	18	0	319.6	15	0	383.1	12	0	478.3	9	0	637.3	6	0	955.4	3	0	1,910.1
31	31	187.1	18	36	309.4	15	30	370.8	12	24	463.0	9	18	616.8	6	12	924.6	3	06	1,848.5
32	32	181.4	19	12	299.8	16	0	359.3	12	48	448.6	9	36	597.5	6	24	895.7	3	12	1,790.7
33	33	176.1	19	48	290.8	16	30	348.5	13	12	435.0	9	54	579.5	6	36	868.6	3	18	1,736.5
34	34	171.1	20	24	283.3	17	0	338.3	13	36	422.3	10	12	562.4	6	48	843.1	3	24	1,685.4
35	35	166.4	21	0	274.4	17	30	328.7	14	0	410.3	10	30	546.4	7	0	819.0	3	30	1,637.3
36	36	161.9	21	36	266.0	18	0	319.6	14	24	398.9	10	48	531.3	7	12	796.3	3	36	1,591.8
37	37	157.6	22	12	258.1	18	30	311.1	14	48	388.2	11	06	517.0	7	24	774.8	3	42	1,548.8
38	38	153.7	22	48	252.9	19	0	302.9	15	12	378.11	11	24	503.4	7	36	754.4	3	48	1,508.1
39	39	149.8	23	24	246.6	19	30	295.2	15	36	368.4	11	42	490.6	7	48	735.1	3	54	1,469.4
40	40	146.2	24	0	240.5	20	0	287.9	16	0	359.3	12	0	478.3	8	0	716.8	4	0	1,432.7

to check development in transportation facilities is a retrograde movement and only means greater efforts to catch up in the future. The development of transportation has always been along the lines of heavier loads per unit, and there is no reason to believe that truck transportation will develop along any other lines. The mechanical development of the truck in the past few years makes it possible to transport greater loads just as soon as the highways are ready to carry them. In addition to this skilled labor situation, from which no immediate relief is offered makes it imperative that development be along the lines of heavier loads per unit. Just as soon as roads are built capable of carrying the loads, trucks of twice the size of those in service today will be built and put in use.

The demands of freight transportation compelled the railroads to increase the size and weight of cars and locomotives and also to increase the carrying capacity of their tracks and bridges. If our highways are to enter into the business of freight transportation—and surely no one will deny that they are to be used for this purpose—they must be built with the example and experience of the railroads as a guide.

The history of our highways shows that we have always been about two jumps behind the needs of the traffic. Highways have been built to carry the traffic of the times and long before the normal life of those highways has passed, new traffic with new demands has developed and the highways have been destroyed. The country has spent and will spend hundreds of millions of dollars building paved highways with a (hoped for) life of twenty or more years, but this life will not be realized if they are built with the idea of limiting the traffic which is to use them.

Let us, then, build highways—less miles if need be—not with the idea of holding back the economical development of truck transportation, but with the determination to provide means of carrying the commerce of the country in any sized packages that may be required.

H. C. BOYDEN.

Formerly Instructor, Engineer School, U. S. A.
Chicago.

The Inland Waterway Problem

Sir—I venture to suggest that *Engineering News-Record* could hardly do a better public service than to publish, in pamphlet form, Charles Whiting Baker's series of articles on the future of inland water transportation. The ancient and careless superstitions as to the economy of such transportation are widespread and hardy, almost proof against the logic of experience.

I should like to see Mr. Baker's article in the hands of every chamber of commerce. It might do some good.

Richmond, Va. E GRAY.

[Suggestions have come from quite a number of interested readers that Mr. Baker's monograph on the waterway problem be printed in pamphlet form. This is being done and a large distribution for it is planned. —EDITOR.]

As Ye Sow, So Shall Ye Reap

Sir—I was glad to see your recent editorial under the above caption, in which you remarked that bolshevism was manifesting itself only in proportion as governments or companies had gone too far in restricting the individuality of the workman by petty laws and parental control.

Another influence, it seems to me, in making for social unrest and economic discontent, has been the over-emphasis which newspapers, magazines, etc., have given to those sensational aphorisms that tell a man he can get anything by struggling hard enough for it—high wages, fame, happiness. A moment's thought will show that hard effort and perspiration, though usually commendable, cannot make a silk purse from a sow's ear. Despite Edison's saying that genius is mostly perspiration rather than inspiration, I feel very sure that, no matter how hard I worked I could never make myself a famous singer, nor a good salesman, nor a surgeon, nor many other performers. Yet evening newspapers print cartoons and snappy sentences stating that energy does everything; that a man has only to apply himself hard enough to move the earth; that output varies directly with input; etc. *Forbes Magazine* puts in: "Two-thirds of promotion is motion."

This campaign of "hustle" and "do it now" has been in progress for several years. As a result, men have hustled and toiled beyond their natural ability, often at duties for which they are not fitted, and now there is disappointment because proportionate rewards have not come. The American idea has been: "Succeed at what you are doing," rather than the French: "Is what you are doing worth while?"

Shouldn't we, as a nation, have more sense of proportion; and shouldn't energy be controlled by brains and a sense of fitness, rather than run wild? As Governor Coolidge recently said: "The curse of the present is the almost universal grasping for power in high places and in low . . . It is always well for men to walk humbly." Even the pious *Engineering and Mining Journal* reprinted this saying of Governor Coolidge!

P. B. MCDONALD,
Assistant Professor of English, College of Engineering, New York University.

The Problem of Handling the "External Relations" of Engineering Societies

Sir—After reading the report of the annual meeting of the American Society of Civil Engineers and the remarks of progressives and conservatives, I think I see something of what is in the air. It seems to be a question of how far professional engineers shall go in advancing their personal and professional interests, as well as public interests, by united work along promotion and salesmanship lines. The American Society of Civil Engineers has acted along these lines in the past, but in a very mild and inefficient manner—in view of possible results, it seems to me.

Thus, as far as "external relations" are concerned, it is a question if a member is satisfied with existing methods and results, or desires more aggressive action along new lines with the assistance of all engineers in the country. If a member does desire the expansion in "external relations," it is necessary to define the machinery and methods by which to accomplish the work. One way would be the formation of the "comprehensive organization" of all engineering societies in the country in a body of the National Chamber of Commerce type. This would make another organization for engineers to support. Another way would be for all professional engineers who desire to do so to unite with the American Association of Engineers, an organization now doing welfare and promotion work quite success-

fully, with a membership of over 10,000 and the support of many engineers of national standing. Membership in this latter association has no relationship to membership in any other national or founder society—an engineer uniting with either or both as he sees fit.

The new "comprehensive organization" now proposed in Question 3 would have some decided disadvantages in its results. The first disadvantage is the alienation of the support of some of the ablest members of the founder societies who lean to conservatism and could not support what would appear to them to be "commercialism" in society affairs. The second would be the formation of an entirely new machine in duplication of a machine (the American Association of Engineers) already well advanced.

The solution seems to me to be, first that the American Society of Civil Engineers adhere to its well-established practices in external relations; second, that all engineers who favor united professional participation in national affairs and who favor "welfare" work in general unite with the American Association of Engineers, keeping also their membership in the primarily technical organizations.

As to the internal changes suggested, I believe the proposed revisions would make the society a more truly national body and would increase the activities of the members.

FREDERICK T. LAWTON,
Assistant Engineer, Department N. Y. State Engineer and Surveyor, Assoc. M. Am. Soc. C. E., Mem. Am. Assoc. Engineers.
Flushing, N. Y.

Sir—The American Society of Civil Engineers has now before it the questionnaire adopted by the annual meeting, consisting of three items under external relations and six under internal relations to which latter has been added a seventh by the Board of Direction. It is here desired to discuss the third question on external relations, which reads:

"Shall the society for the purposes set forth in Questions 1 and 2 actively co-operate in the creation of the comprehensive organization as outlined in the Joint Conference Committee Report? (Report, Division C, page 10-19).

This question is the crux of that part of the questionnaire devoted to external relations, and the voter naturally inquires what is the comprehensive organization proposed? It seemed to the members of the Joint Conference and Development Committees that the report set forth the program with all necessary clearness, but since a committee of members of the Board of Direction have been willing to append their names to such a misinterpretation relating thereto as are contained in the report of the board's committee, it is evident that the clarity of the report was overestimated.

In further explanation it is to be said that it was the opinion of a large majority of the Development Committee that for so-called welfare work a comprehensive organization, embracing if possible all the engineers of the country, was most desirable. Some felt that it was unwise to burden a technical society with welfare work lest the latter should divert attention from the technical, and others felt that in no existing organization could all the engineers be assembled, and that what was wanted was the quickest method of bringing them together. Having had experience with several conventions on co-operation, and with the convention to consider a National Department of Public Works, it was concluded that the best way to get the profession together would be to ask every organization of engineers now existing to arrange to have itself represented in a national council, and in order to finance the project to ask the societies to contribute thereto on a *per capita* basis.

Accordingly it is proposed that an invitation be issued to all the engineering organizations of the country to be represented at such a convention, the date of which has been set for May next, when it is expected a formal organization will be created.

It does not seem to the writer that in sending delegates to such a convention or contributing to its support the society is doing anything different in principle than it has been doing for some years past, in appointing delegates to Engineering Council and appropriating money from its treasury for that council's use. It is not possible for the writer to understand how the proposed national organization can in anyway supersede, subvert, control or unduly influence the American Society of Civil Engineers, any more than the election of members of Congress by the same people that elect representatives in the state legislatures enables the former to supersede, subvert, control or unduly influence the state governments. Each organization will have its own field, one primarily and principally technical, the other entirely non-technical and purely welfare.

As to financial obligation, the committee on budget which investigated that subject and had the benefit of the counsel and advice of the late secretary of the society, reports that the total additional expense to the society for the proposed national council would be $8,500, and in view of the liberal pension granted to the retiring secretary it can hardly be said that this burden upon the resources of the society would be expected to seriously weaken it.

To be specific, the Joint Conference Committee unanimously, and the Development Committee by a vote of sixteen to four, recommend that representation in the national council be accorded to each national society of engineers having a membership of 200 or more, and to each local, state or regional society having a membership of 100 or more, provided that where a local society is affiliated with a state organization it cannot be represented as a local society and as a state society also; and further they recommend that national societies contribute annually $1.50 per member, and local, state and regional societies, $1 per member to the treasury of the national council; and that there be created from the national council an executive board of not to exceed thirty members, divided between national and other organizations in proportion to their membership. As a safeguard to the national societies it is provided that they shall select their own members of the executive board while the representatives of the other organizations thereon are to be elected by their members in the council. The council is to maintain a headquarters with a paid secretary and necessary assistants.

In the foregoing the term "welfare" has been used to indicate those activities relating to the public and the profession which are not purely technical.

GARDNER S. WILLIAMS,
Member of Development Committee, Am. Soc. C. E., and of Joint Conference Committee.
Ann Arbor, Mich.

HINTS FOR THE CONTRACTOR

DETAILS WHICH SAVE TIME AND LABOR ON CONSTRUCTION WORK

Pipe Pusher Cuts Cost of Under-Pavement Cable Conduits

By C. A. FRANKINHOFF
Kansas City, Mo.

OVER 22c. a foot was saved as compared with cutting through the pavement by using a pipe pusher to install across-street, under-pavemnt pipe conduits for electric cable on recent work directed by Black & Veatch, engineers, of Kansas City, Mo. Complete records of the operations were kept and are summarized in the accompanying table. The notes to the table indicate the difficulties experienced in pushing the pipe. To start pushing, pits 8 ft. long, 20 in. wide and 20 to 36 in. deep had to be dug at one side of the street; these are the pits to which column nine of the table has reference.

TIME AND COST RECORDS OF INSTALLING UNDER-PAVEMENT CONDUIT WITH A PIPE PUSHER

Number	Size of Pipe, In.	Distance Pushed Ft.	Time to push, Hour	Time to Pull, Hour	Number Men on Machine	Pipe In, Below Curb, In.	Pipe Out Below Curb, In.	Dig and Back Fill Pit Hour	Crossing Cost per Ft.
1	¾	37	4½	1½	2	8	X	4	$0.129
2	1¼	44	3	1	2	18	16	5½	0.108
3	1¼	46	3½	1½	2	18	22	5½	0.111
4	1¼	35	1½	¾	2	18	6	5	0.107
5	1¼	44	4	1¼	2	12	48	7½	0.139
6	1¼	35	2	1	2	18	18	4½	0.111
7	1¼	44	4½	1½	2	18	108	12½	0.213
8	1¼	30	4	2	2	18	X	11	0.273
9	1¼	30	2	1	2	18	18	6	0.150
10	1¼	33	3½	1½	2	18	18	5	0.151
11	1¼	33	4	1½	2	18	8	4½	0.159
12	1¼	45	5	3	2	24	24	11	0.189
13	1¼	65	7	2	2	22	24	12	0.162
14	1¼	65	12	2	2	18	X	11	0.192
15	1¼	56	4½	1½	2	20	18	9	0.134
16	¾	70	12	3	2	22	18	11	0.186
17	¾	95	9	3	2	22	22	9	0.110
					below pavement				
18	1¼	38	6	2	2	18	24	5½	0.177
19	1¼	38	6	2	2	18	18	4	0.158

(1) Up through pavement. (2) Easy through. (3) Hit rock. (4) Easy through. (5) Hit rock; time lost in digging for pilot. (6) Easy through. (7) Deflected down and to left; time lost in hunting for pilot. (8) Came up through pavement. (9) Easy through; backfill slowed due to cold weather. (10) Easy through. (11) Broke machine; repairs on hand. (12) Veered to left; Tarvia to replace. (13) Ran into rock, had to repunch. (14) Ran into gas main at 50 ft., dug up pavement at main; set machine and pushed from main to complete crossing. (15) Ran easy all way; veered to right about 10 in. in push. (16) Time lost in cutting pipe for machine. (17) For this push and the one above hole was cut in pavement for machine setting; ran through easy and on exact line. (18) Veered to left 6 in.; pushed hard. (19) Ran true and pushed easy; men took it easy; last hole.

The machine purchased for this job cost $75.50 f.o.b. at the factory, with all appliances for 1¼-in. and ¾-in. pipe. The express on the complete outfit, weighing about 80 lb., amounted to $5.25. The repairs to the machine totaled $7.25 for a total push of about 1,000 ft. under bituminous pavement.

All labor used on the machine was paid at the rate of 50c. per hour. The average of the tabulated costs of crossing streets compared with the cost of crossing the same amount of Tarvia pavement by trenching are:

Cost per foot with pipe pushing machine	$0.157
Cost per foot by cutting through pavement	0.380
Saving per foot	$0.223

This saving of $0.223 per ft. on 883 ft. of crossing amounted to $196.90. This amount less the cost of the machine express, and repairs gives an increased profit of $108.90, on this small job. The contractor still has the machine in as good a condition as when first used.

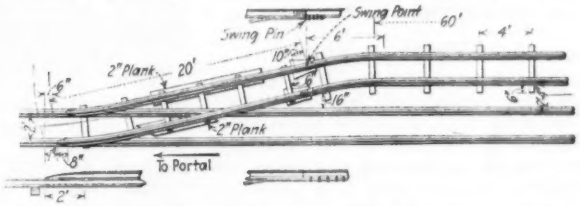
Frogless Switch Sidetracks Muck Cars at Tunnel Heading

By N. A. ECKERT
Construction Engineer, Hetch Hetchy Project

CARS for hauling muck used in the tunnels of the Hetch Hetchy project have a capacity of 54 cu.ft., the bodies being 4 ft. in width and the gage 2 ft. They are ordinarily handled in trains of five cars by a storage battery locomotive. In order to avoid moving them an excessive distance by hand in making up the loaded train and to facilitate getting empty cars up to the face, the switch shown in the accompanying sketch was devised by the foreman in charge at Early Intake Tunnel.

The rails in the main tunnel track are 30-lb. A. S. C. E. section. The switch and siding are constructed of 20-lb. steel, the rails being tapered down at the points so as to give an easy run on to the main truck. Flat metal ties are used on the siding made of ¾-in. iron, 3 in. wide and spaced 4 ft. center to center.

The entire switch and siding can be lifted bodily in one piece and moved ahead to a new location. Preparation for a new location is made merely by levelling the ground even with the top of the main tunnel rails. It takes only a few minutes to move the switch ahead after levelling up for it. If necessary it can be removed back before blasting and replaced afterward.



The device is hinged at the swing point as indicated on the sketch. The joint in the rail opposite the swing point opens when the switch is moved, which is done simply by lifting the points from the main track and swinging the whole switch.

The switch at the heading end is made somewhat lighter than that on the opposite end of the siding because on this work the former is operated about five times as often as the latter. The switch at the heading end handles only the empty muck cars while the electric locomotive must pass over the switch at the rear.

With this type of switch it is possible to store cars so close to the heading that they do not have to be moved more than about 50 ft. by hand. With the type of switch commonly used, involving the cutting in of a frog, the moving of which may require half a shift, it is not generally advisable to move the siding more often than once in two or three weeks. This sometimes requires that cars be handled a distance of three hundred feet by hand.

Of course the use of this type of switch would not be warranted where small cars are used which can be conveniently moved on a slick-sheet and kept right at the tunnel heading without the use of any switch.

NEWS OF THE WEEK

New York, March 4, 1920

Construction Division Auxiliary Meets and Organizes

The first annual meeting of the Construction Division Auxiliary was held in New York, Feb. 28, with Col. Peter Junkersfeld, of Boston, presiding. By-laws were adopted, officers elected and the place set for the next annual meeting. A dinner was held in the evening. Throughout, the proceedings partook of the nature not of a formal gathering but of a family or fraternity meeting.

The by-laws set forth as the objects of the association the perpetuation of the ideals and spirit of the Construction Division of the Army, and the furnishing of means whereby the relationships established during the war may be perpetuated. The annual meeting is to be held on the fourth Saturday of February. All officers and former officers of the Construction Division and such civilians as may be invited by the Auxiliary are eligible to membership. Management of the Auxiliary will be in the hands of a president, a vice president, a secretary, a treasurer and a board of forty-eight governors. Annual dues were fixed at $2 per annum.

Next Meeting in Chicago

Chicago was selected as the place for the next annual meeting. The chief item of business, outside of the work of organizing, consisted of the discussion and unanimous passage of a resolution pledging the Auxiliary as a body and the members as individuals as a reserve to be at the call of the Government in case of another emergency.

Secretary Baker, Assistant Secretary Crowell and Maj. Gen. I. W. Littel were elected honorary members.

At the dinner Secretary Baker and Brig. Gen. R. C. Marshall, Jr., head of the Construction Division, were the guests of honor. The only address was that of the Secretary, who gave unstinted praise to the work of the officers and men of the Construction Division, saying that future historians would characterize the building of the cantonments, of port structures and warehouses as an Aladdin-like achievement. He said that it was impossible to appraise with absolute sureness the various accomplishments auxiliary to the actual fighting, but he would be inclined to put second the cantonment construction, awarding first place to the ferrying of 2,000,000 men safely through submarine-infested waters.

Officers were elected for the ensuing year, Col. C. C. Wright, of Chicago, as president; Col. Joseph N. Wilcutt, of Boston, vice president; Major George Gibbs, of Washington, secretary, and Col. Warren Roberts, of Chicago, treasurer.

Gossip Regarding New York Section, Am. Soc. C. E.

Disappointment is being expressed among the younger members of the American Society of Civil Engineers at New York that in the election of officers of the new New York Local Association of Members recognition was not given to the younger element. All of the officers are from the older members, and the majority are looked on as being conservative or ultra-conservative.

It has also become known that at the organizing meeting it was proposed that the New York association should take a stand against the report of the Development Committee. That there may be broad discussion and assurance that there will be no unrepresentative action, there is talk of an effort to insure a large attendance of the younger members and those in sympathy with the Development Committee's report at the first general meeting of the association. Call for that meeting has not yet been issued.

Colonel Potter Heads Mississippi River Commission

Colonel Charles L. Potter, Corps of Engineers, has been confirmed by the Senate as president of the Mississippi River Commission. Lieutenant-Colonel Herbert Deakyne and Lieutenant-Colonel Harry Burgess have been designated as members of the commission. The new president succeeds Colonel Curtis McD. Townsend, who reached the retirement age early in February. Colonel Potter was born in Maine, Jan. 24, 1864. He entered the Military Academy in 1882. He served with the Cavalry until 1887, when he was transferred to the Engineer Corps. He was graduated from the Engineer School of Application in 1889.

Illinois Members Am. Soc. C. E. Discuss Questionnaire

At a meeting of the Illinois Association of the American Society of Civil Engineers, held in Chicago Feb. 25 to discuss the questionnaire on the future activities of the society, the main topic was the proposition for a separate joint organization to handle the welfare work for the several national societies. This proposition was approved in principle, although the affirmative vote did not endorse any particular plan. It was decided, therefore, to secure further information from the parent society and to discuss this subject at a later meeting before taking any final action that would commit the association to the support of a definite plan.

Goethals' Concrete Block Tunnel Declared To Be Impracticable

Brief of Chief Engineer Holland States Objections to Capacity, Shell Strength, and Cost

Specific objections to the 42-ft. concrete-block tunnel recommended for the Hudson River vehicular crossing by General George W. Goethals two years ago are presented in an engineering brief of C. M. Holland, chief engineer to the tunnel commissions, made public on March 1. This brief is the reply to a series of questions addressed to the commission by General Goethals after the publication of the engineer's report on tunnel plans, abstracted in *Engineering News-Record* of Feb. 19, 1920, p. 357. These questions asked for a statement of the reasons on which the criticisms of the large-size concrete-block tunnel in the report were founded; the traffic capacity had been declared over-estimated, the tunnel design condemned as too weak and not adapted to Hudson River conditions, and estimates of cost and time of construction rejected as too low.

Limited Traffic Capacity

As to traffic capacity, Mr. Holland's brief asserts that the two 22½-ft. roadways of the Goethals tunnel cannot carry three lines of vehicles. With two lines of trucks each 8 ft. wide and one line of passenger cars 6 ft. wide, a total clearance of only 6 in. is left; each of the roadways can therefore carry only two lines of traffic and the 42-ft. tunnel will carry only four lines (two on each deck) instead of six as estimated.

Discussing the matter of strength, the brief presents three stress-sheets to show the deficient stability of the block ring 36 in. thick (42 ft. outside diameter). In addition it asserts that tunnel experience shows strength and rigidity of tunnel shell to be necessary, especially in the cross joints, and that the block tunnel does not provide strength here. In the Hudson River, where soft ground of widely varying nature is encountered, great lateral strength must be provided and the shell must be maintained impervious, while the block tunnel is "the worst possible to meet these conditions" on account of its lack of rigid connection at the cross joints and the impossibility of maintaining these joints tight when not rigidly connected.

Many items of the cost estimate are attacked. Among these are: concrete blocks, estimated at $11, should be at least $33 per cu.yd.; cost of excavation is wrongly classified, is erroneous in

amounts, and is too low in its units, and will total $9,700,000 instead of $3,730,000. Items such as ducts, sewer reconstruction, etc., are omitted; real estate is not included, and $2,500,000 should be added to cover it; plant cost will total over $2,600,000 instead of $1,435,000, and two shields must be used instead of one. The estimated time of three years for construction is questioned because it would require a rate of progress twice that attained in the best similar previous work, although being much larger the 42-ft. tunnel should progress more slowly.

In support of the chief engineer's brief, the Board of Consulting Engineers of the tunnel commission reports that the answers given in this brief to General Goethals' questions are conclusive and show "the impossibility of the serious consideration of the project as a matter of construction."

To Complete Aqueduct Enlargement for Water Supply Only

Completion of the Montreal aqueduct enlargement for water-supply purposes only, together with provision of additional pumps, filters and storage reservoirs is recommended by R. S. and W. S. Lea, consulting engineers, Montreal, in a report to the City Administrative Commission of which E. R. Decary is chairman. It is estimated that the completion of the aduedict enlargement along the original lines for combined water supply, electric light and power purposes would cost $10,000,000, whereas the modified plan recommended would cost $1,683,000.

The engineers advise installation of a new motor-driven pumping plant at a cost of $850,000; that the filter plant capacity be increased to a capacity of 144,000,000 U. S. gal. at a cost of $2,000,000; and that "additional elevated reservoir storage" sufficient to give "8-hr., stand-by storage over and above the capacity required for equalizing purposes" be provided.

A contract for enlarging the aqueduct was let in July, 1913. The enlargement work was stopped by the break of the closed conduit alongside it on Dec. 25, 1913, and was continued with interruptions until the autumn of 1917. On Dec. 26, 1917, the contract was cancelled by mutual consent and the claims of both sides referred to arbitration. The terms of the award were summarized in *Engineering News-Record*, Sept. 11, 1919, p. 534. The break in the "lateral conduit," as it was called locally, was described at length in *Engineering News*, Jan. 1, 1914, p. 54.

Suspended Army Contracts Are Nearing Settlement

The construction division of the Army has liquidated 99 per cent of the uncompleted portions of suspended contracts. Their aggregate value was $15,452,000. The Engineer Corps has liquidated 98 per cent of its suspended contracts, which totalled $173,964,000.

Herbert C. Hoover Receives Washington Award

Formal presentation of the Washington Award, founded in 1916 by John W. Alvord, to Herbert Clark Hoover was made Feb. 28 in Chicago. The occasion was a dinner arranged by the Western Society of Engineers to which is entrusted the handling of the award in conjunction with members of the Founder societies. In the words of the donor the award is to be presented "to a member of the engineering profession who has accomplished much for the world about him in vital, important, far-reaching ways, and whose services in general have been noteworthy for merit in promoting the public welfare."

Herbert C. Hoover Receives Washington Award

THE TOKEN OF AWARD

Charles F. Loweth, chairman of the Washington Award Commission made the presentation speech recounting Mr. Hoover's attainments. Onward Bates spoke as a representative for the American Society of Civil Engineers, James R. Bibbins for the American Society of Mechanical Engineers, Bion J. Arnold for the American Institute of Electrical Engineers and Charles H. MacDowell for the American Institute of Mining and Metallurgical Engineers.

Mr. Hoover, in his address, stated that he never could have accepted the award except in a measure as homage to the 1000 engineers who—many with splendid personal sacrifice—had associated themselves with him. The subject of his address was "The Interrelationship of General Industry and Food Production and Distribution." His most startling statement was that within five years this country will be faced with the necessity of importing foodstuffs if our exports are developed as rapidly in the next five years as in the past five years. Farming must be made more attractive economically if a proper balance between it and industry is to continue, he asserted. In the line of practical remedies he discussed the weakness in our present railway situation in which the annual car shortages restrict the free flow of commodities. Besides increasing rail facilities he suggested improving the waterways from the Great Lakes to the Atlantic seaboard by way of the St. Lawrence.

A suggested second point of attack in reducing the cost of marketing was to remove every impediment to free trade in produce. He believes in regulation, rather than nationalization, of over-swollen units. The third factor in reducing marketing costs, he pointed out, was to reduce the number of persons engaged in the distribution of foodstuffs.

Despite a seven-hour delay in the arrival of Mr. Hoover's train, which prevented his appearance until nearly midnight, the 700 members of the Western Society of Engineers, the Founder societies and guests present at the dinner remained to do honor to him. A long list of speakers and community singing and other entertainment arranged in the emergency by the program committee kept the presentation audience intact and in a happy frame of mind for Mr. Hoover's delayed reception.

All Topographic Interests To Meet in Washington March 9

All interests concerned in United States topographic mapping have been invited to participate in a general discussion of the subject in Washington, March 9, with the Federal Board of Surveys and Maps created by the President on Dec. 30, 1919. The board, which recently met and effected its organization and adopted its by-laws, is composed of one representative from each of fourteen map making agencies of the Government executive departments.

At the coming meeting, which will be the first public session held by the board, an open letter of the chairman, O. C. Merrill, says it is desired to have all interested agencies represented in order to bring out a full knowledge of the needs for a general topographic map of the United States, and also the means by which its preparation can be expedited. The letter expresses the further desire of the board to hear all opinion on the general policies which the board should pursue in coordinating the work of the various agencies of the Federal Government, on the relations which should be maintained between the Board and non-Federal agencies, and on the practicability of maintaining these relations through a committee which would represent the several non-Federal agencies, and which could serve both as a means of correlating their activities and as a medium of co-operation between them and the board.

The purpose of the board, as incorporated in its by-laws, is "to co-ordinate and standardize all surveying and mapping activities of the Federal Gov-

ernment, and to harmonize these with similar non-Federal activities in the interests of economy and efficiency." The by-laws also declare it to be the policy of this board to invite full co-operation from any Federal or non-Federal map-making or map-using agency by the presentation of its views and by representation on committee having under consideration matters of interest to such agency.

The board will hold public meetings in Washington on the second Tuesday of January, March, May, September and November of each year. A central information office will be established in the U. S. Geological Survey for the purpose of collecting, classifying and furnishing to the public information concerning all map and survey data available in the several Government departments and some other sources.

At the meeting of March 9 the general discussion will be preceded by a talk by W. O. Hotchkiss, State Geologist of Wisconsin.

Testing Engineers Meet

As a further step toward standardizing methods and limits in testing materials for road construction work, a 5-day conference of the committee on tests of the American Association of State Highway Officials was held recently at the office of the Bureau of Public Roads, Washington, D. C. Testing engineers from 22 states were in attendance. The first day of meeting, the committee broke up into sub-committees for the consideration of test methods of bituminous materials, non-bituminous materials, concrete materials and test limits. Those attending the conference were, T. R. Agg, chairman, Iowa; R. L. Saunders, Connecticut; C. F. Purrington, New Hampshire; R. B. Gage, New Jersey; J. G. Bragg, New Jersey; N. H. Ulman, Pennsylvania; A. S. Rea, Ohio; F. L. Roman, Illinois; D. V. Terrell, Kentucky; J. F. Grimes, Kentucky; F. C. Lang, Minnesota; R. B. Dayton, West Virginia; M. O. Withey, Wisconsin; F. T. Maddocks, California; J. C. Cooper, Iowa; R. A. Seaton, Kansas; F. C. Rossel, Maryland; H. W. Leavitt, Maine; R. B. H. Begg, Virginia; W. F. Fallis, North Carolina; A. W. Dean, Massachusetts; W. D. Martin, Ohio; H. B. Henderlite, North Carolina; B. H. Hutchinson, Delaware. Recommendations of these engineers upon test methods and limits will soon be available.

Railway Engineers To Meet in Chicago

The American Engineering Association will hold its 21st annual convention in Chicago on March 16 to 18. Except for the annual dinner on the 17th the time will be occupied entirely with consideration of the numerous committee reports. The usual exhibition of railway appliances and machinery will be at the Coliseum, March 15 to 18.

Opinion of Consulting Institute on Pittsburgh Bridge Case

The council of the American Institute of Consulting Engineers has voted its condemnation of the practice current in Pennsylvania of entrusting the design of important engineering structures to architects.

The Pennsylvania tendency to use architects for engineering work in bridge design had its beginning in October, 1919, when the commissioners of Allegheny County, which includes Pittsburgh, turned over to firms of architects the design and construction supervision of two large bridges. Brief mention was made of the matter in *Engineering News-Record's* "Emergency Bulletin" of Oct. 23, 1919. It was again discussed editorially in this journal Oct. 9.

Additional architectural aggression in the field of engineering was contained in a letter to the Governor signed by the secretary of the Pennsylvania Art Commission urging the design by an architect of the proposed Delaware River Bridge at Philadelphia. The letter was published in *Engineering News-Record*, Jan. 29, 1920, p. 250. Several Pennsylvania engineering societies have sent resolutions of protest to the Governor.

Architectural Encroachment

Since it first became apparent the growing encroachment on engineering of the Pennsylvania architects has been under consideration by several of the nation's leading consulting engineers. The result is the following resolution recently passed by the council of the American Institute of Consulting Engineers:

Whereas, It is reported to the Council of the American Institute of Consulting Engineers that responsibility for the design and construction of certain important bridges has recently been entrusted to firms of architects; and

Whereas, In the construction of bridges of any type, and for any purpose, the engineering problems are of vital and first importance in providing safety, adaptibility and durability of the structures produced; and

Whereas, The external architectural treatment and decorative effect is secondary in importance to the engineering design; therefore be it

Resolved, That the Council of the American Institute of Consulting Engineers condemns and protests against public bodies entrusting the responsibility for the design or production of such important engineering structures to professional men whose training and practice is in a wholly different field, and who must, therefore, delegate to subordinates the solution of the fundamental problems of primary and vital importance. The Council condemns a division of the responsibility which will inevitably result by departing from ordinary procedure, and urges that no further work of the kind be entrusted to any except specialized engineers of acknowledged standing. The Council recommends, however, that in the case of monumental structures, the decorative effect secured by architectural treatment shall be considered by specialists engaged for that specific purpose.

First Issue of "The Military Engineer" Appears

Superseding *Professional Memoirs*, inaugurated eleven years ago by the Corps of Engineers, U. S. A., the first number of the new bi-monthly journal, *The Military Engineer*, official publication of the newly created Society of American Military Engineers, made its appearance this week. Compared with its predecessor it exhibits in its contents as well as in typography and general makeup a far keener appreciation of the possibilities of modern publication methods than did *Professional Memoirs*. The new journal is edited by Colonel P. S. Bond, former commandant of the Army Engineer School of the A. E. F. at Langres, France, and is designed as a medium by which members of the Corps of Engineers, the National Guard, ex-service men and engineers in civil practice may keep informed as to technical developments bearing upon national defence.

Leading Article on Construction

The leading article in the January-February number, "Engineer Construction in France," is by Colonel J. A. Woodruff, formerly deputy director of construction and forestry, A. E. F. Colonel R. R. Ralston discusses engineer duties in the field of war and there are two contributions on the use of the airplane in surveying and mapping. "Soldiers First!" is the title of an article by Colonel J. C. H. Lee, former chief of staff, 89th Division. A revolt against excessive paper-work, letter-writing and report-making is embodied in the remarks of Colonel Ernest Graves, formerly section engineer, advance section, S. O. S., A. E. F.

Articles dealing with civilian work are those on Lock D, Cumberland River, by R. F. Pafford, senior engineer; Key Bridge cofferdams, by J. T. Talman, assistant engineer; river and harbor improvements, by Major J. R. Slattery, and surges in Gaillard cut, by Major R. Z. Kirkpatrick. There are several pages of editorials and general news items.

National Federation Construction Industries To Meet

The first annual meeting of the National Federation of Construction Industries will be held at the Hotel Sherman, Chicago, March 24-25. The chief business of the meeting will be consideration of several important proposed changes in the by-laws of the organization. Through changes in the by-laws, it is proposed to increase the number of vice-presidents, create an advisory board, provide for a staff council and take measures to develop district organization.

President Wilson Signs District of Columbia Zoning Bill

A Congressional act creating a zoning commission for the District of Columbia with directions to the commission to establish, within six months from the passage of the act, height, area and use districts, and necessary regulations therefor, was signed by President Wilson on March 2. The intent of the act is "to protect the public health, secure the public safety, and to protect the property of the District of Columbia." The commission is an ex officio body of six, consisting of the Commissioners of the District of Columbia, the Officer in charge of Public Buildings and Grounds of the District, and the Superintendent of the U. S. Capitol Building and Grounds.

PUBLIC HEARINGS PROVIDED

Before the expiration of 6 months after the act become effective public hearings must be held on the proposed districts and on the regulations governing the same. The bill provides for changes in districts on petition of property owners. After the districts are created no new buildings or old buildings made over or otherwise changed can be used until "a certificate of occupancy" has been obtained from the zoning commission. Buildings "erected, altered or raised, or converted in violation" of the provisions of the act or of orders and regulations thereunder are declared by the act to be "common nuisances" and the owners or persons in charge of maintaining such buildings, upon conviction of maintaining such nuisances, are to be liable to a fine of not more than $100 a day for every day the nuisance is permitted to continue, besides being subject to abatement of the nuisance by court order. The enforcement of the provisions of the act and of orders and resolutions adopted by the zoning commission is vested in the Commissioners of the District of Columbia. An appropriation not to exceed $5,000 for the expenses of the Zoning Commission is authorized.

Members of New Jersey Sewage Works Association Meet

At a meeting of the New Jersey Sewage Works Association held at Trenton, N. J., Feb. 25, C. G. Wigley, formerly chief of the Bureau of Engineering of the New Jersey State Department of Health and now with Clyde Potts, consulting engineer, New York City, was elected president and Frederick T. Parker, of the Atlantic City Sewerage Co., Atlantic City, N. J., was re-elected secretary and treasurer. It was voted to have two meetings during the coming year for purposes of inspection visits to sewage works and it was also decided that a special committee should be appointed by the president to take into consideration the desirability of enlarging the scope of the association to include operators of water purification works, the committee to report at the next meeting.

Confirms Contract for a Part of the Detroit Belle Isle Bridge

The Detroit City Council recently confirmed the contract with the Candler Dock & Dredge Co., of Detroit for the construction of the subway for street traffic under Jefferson Ave. at the approach of the proposed Belle Isle bridge. Although the amount of the contract, $360,190 was about 20 per cent in excess of the engineers' original estimate, it was considerably less than the one bid which was received and rejected when proposals were asked for in January; also the present contract was recommended by the City Department of Public Works and by Esselstyn, Murphy & Hanford, the engineers in charge of the complete Belle Isle bridge project.

This is part of the $3,000,000 Belle Isle bridge job for which bonds have been voted. As originally planned the subway approach was to be a steel structure but plans were later changed specifying a structure of reinforced concrete. Work will proceed on the main approaches and the bridge proper as soon as word is received that President Wilson has signed the special bill providing for a closed span bridge to be constructed across the river on the American side of Belle Isle.

Handling Machinery Men Meet

On Feb. 26 and 27 there was held in New York City the annual meeting of the Material Handling Machinery Manufacturers Association. An appreciable step was made toward the intergration of the industry of making material-handling machinery of all sorts. Several papers descriptive of modern handling equipment and installations were read but the main value of the sessions was the reiteration of the importance of acting as a unit in the development of the idea of handling by machinery rather than by man power.

Higher Price for Water Denied

The right to charge a higher price for water sold in bulk to the City of Hoboken for distribution by the city to consumers has been denied by the New Jersey Public Utility Commission. The company supplies water under a 25-year contract which it claims is now unprofitable. The commission adheres to its ruling of a few years ago in the Wildwood case to the effect that a company must fulfill its contract even though it proves to be at a loss, so long as the loss doen not threaten to jeopardize the service rendered to the public.

Engineers Predominate on Snow Removal Board

To study the problem of snow removal and devise means of preventing a great traffic tie-up such as was created by the snow storms last month the Mayor of New York recently appointed a snow-removal board of representatives of various municipal bureaus and departments. In the total membership of eleven on the board there are six engineers. The board consists of the following:

John Kenlon, Fire Department, chairman; Inspector Alfred W. Thor, Police Department; Nelson P. Lewis, Board of Estimate; Captain John P. Leo, Board of Standards and Appeals; Merritt H. Smith, Water Department; Edward Bryne, Department of Plant and Structures; Arnold B. MacStay, Street Cleaning Commissioner; John P. Binzen, engineer, Bronx Borough President's office; Philip Farley, engineer, Brooklyn Borough President's office; Amos Schaeffer, engineer, Manhattan Borough President's office; Dr. Royal S. Copeland, Health Commissioner.

Idaho Engineering License Exams To Be Given March 9

The second semi-annual examinations under the state engineering license law of Idaho will be given in Boise March 9, it has been announced by Paul Davis, director of the State Bureau of Licenses. The license law applies only to civil engineers, and it defines civil engineering as any engineering practice that is not mining, metallurgical or military. The license fee is $10 for residents of Idaho and $25 for those licensed or registered elsewhere.

Alabama Votes Road Bonds

At an election held recently Alabama voted to amend its constitution so that road bonds amounting to $25,000,000 could be issued. The vote to amend was overwhelming. The same day the state voted its bonds Jefferson Co., authorized a $5,000,000 issue; also for roads.

House Votes Increased Speedway Hospital Appropriation

The much discussed appropriation for the speedway hospital at Chicago was practically settled when the House on Feb. 28 voted to increase the appropriation for its completion from $3,000,000 to $3,400,000. The House conferees had been unable to agree on the amount. The Senate had increased the appropriation to $4,000,000, but it is believed that the Senate conferees will accept the figure voted upon in the House.

The House amendment provides that no part of the appropriation is to be used to pay any profit to either the owners of the land or the owners of the uncompleted buildings, or to the contractor for the completion of the work.

Army Bill Places Construction Division in Q. M. Corps

(Washington Correspondence)

As was anticipated the Army Reorganization bill places the Construction Division of the Army in the Quartermaster Corps and the Quartermaster General is charged with "the direction of all work pertaining to the construction, maintenance and repair of buildings, structures and utilities connected with housing the officers and enlisted

men of the Army." The Military Affairs Committee receded, however, from its former position in regard to the Chemical Warfare Service, and the bill, as does the Senate measure, gives that service a separate entity.

In providing 600 officers for the Engineer Corps the bill upsets the proportion of officers and enlisted men to such an extent that its provisions would be very hard to carry into practice. It is anticipated, however, that the fault in that respect will be remedied by an amendment during the legislative course of the measure. The 12,000 enlisted men assigned to the corps, to be properly officered, would require 640 officers. In addition the Engineer Corps requires, more than do most of the military divisions, a large number of officers for staff operations and to handle the civil work.

In France it was found that there must be one engineer regiment for each nine regiments in other branches. This was considered the irreducible minimum. A relationship of one to six was held to be much more desirable. Despite these well-known facts, the House bill makes the proportion 1 to 20.

Calendar

Annual Meetings

AMERICAN RAILWAY ENGINEERING ASSOCIATION; 1426 Manhattan Bldg., Chicago; March 16-18, Chicago.

NATIONAL FEDERATION OF CONSTRUCTION INDUSTRIES, Drexel Bldg., Philadelphia; Chicago, Mar. 24, 25.

NATIONAL FIRE PROTECTION ASSOCIATION, 87 Milk St., Boston; May 4-6; Chicago.

AMERICAN ASSOCIATION OF ENGINEERS; 63 E. Adams St., Chicago; May 10, 11, St. Louis, Mo.

AMERICAN WATER WORKS ASSOCIATION, New York City; Montreal, June 21-26.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Asbury Park, N. J., June 22-25.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Aug. 30-Sept. 3.

ENGINEERING SOCIETIES

The Engineers' Club of Toronto (Ont.) has just closed its twentieth year. The club's board of direction at a recent meeting decided to double the entrance fee as the membership has almost reached the accommodation limit of the club's present quarters. The following officers have been elected for 1920: President, Melville P. White; first vice-president, Tracy D. Le May; second vice-president, J. B. Carswell; third vice-president, W. R. McRae; secretary-treasurer, R. B. Wolsey. The directors for the ensuing year are: J. R. W. Ambrose, A. M. Cooper, E. G. Hewson, Charles H. Hays, Arthur H. Hull, J. H. McKnight, L. V. Rorke, J. R. W. Wainwright, Walter F. Wright, Maj. E. W. Wright, T. S. Young.

The Engineers and Architects' Club of Louisville, Ky., was addressed at a recent meeting by Lucien J. Beckner, consulting geologist of Winchester, Ky. His subject was the natural resources of Kentucky. A report on pending good roads legislation in the state was presented by the club's Good Roads Committee. The club intends to back any good legislation pertaining to roads with all its power and to discourage anything therein which may not meet its approval.

The Seattle Chapter, A. A. E., held its annual meeting Feb. 9 and elected John L. Hall, president; Maj. Carl H. Reeves, vice-president; and Capt. Bertram Bean, secretary-treasurer.

The Cleveland Chapter, A. A. E., has announced that a bill relative to the limited employment of county draftsmen in Ohio, and amending a section of the Ohio general code, has passed both branches of the state legislature and is awaiting the governor's signature. W. A. Stinchcomb, county surveyor of Cuyahoga County, Ohio, was active in originating the bill. He secured for it the support of the Cleveland Chapter, A. A. E., and through the latter the endorsement of other engineering societies throughout the state. Also through the efforts of Mr. Stinchcomb the bill was introduced and actively pushed through the state senate and house. The bill removes the limitations on the number and salaries of draftsmen that may be employed by county surveyors who maintain drafting rooms. Under the present law, county surveyors are limited to four men at a maximum of $1,500 per year.

The Engineers' Society of St. Paul (Minn.) at its recent annual meeting elected president, E. V. Willard, commissioner of drainage and waters for the State of Minnesota. Mr. Willard is an associate member of the American Society of Civil Engineers. John E. Mullin, chief engineer, State Highway Commission of Minnesota, was elected vice-president; E. A. Goetz, chief engineer, St. Paul Foundry Co., was elected secretary, and G. L. Mason, landscape architect, was elected treasurer.

The Colorado Society of Engineers at its recent annual meeting and dinner in Denver, Colo., elected R. G. Hosea, president; F. C. Dreher, vice-president; C. B. Daniels, secretary-treasurer. The theme of the evening was "1920—What Progress for Colorado?" The prominent speakers were the Hon. Delph Carpenter of Colorado, John E. Field, former state engineer of Colorado, and J. G. McMurray, general attorney of

The North Carolina Society of Engineers has adopted a constition that provides for amalgamation with the American Association of Engineers. The principal speaker in favor of the amalgamation was Doctor W. C. Riddick, president of the North Carolina State College and president of the society. R. C. Bailey addressed the convention and advised the members of financial arrangements which the association would make upon amalgamation. New officers were not elected.

PERSONAL NOTES

P. C. PAINTER, paving specialist and late captain, Engineers, U. S. Army, has joined the engineering staff of the Eastern Paving Brick Manufacturers' Association as a district engineer. For several years before the war Mr. Painter was connected with the Paving Commission of the City of Baltimore and while in the military service in France was in charge of a portion of the road construction and maintenance there.

COLONEL CHARLES KELLER, Corps of Engineers, was decorated with the Distinguished Service Medal by the Secretary of War in the latter's office in Washington Feb. 20, 1920 The medal had been previously awarded to Colonel Keller for his distinguished services in France as Deputy Chief Engineer, A. E. F., and as Assistant to the Chief Engineer, A. E. F., at general headquarters.

H. D. BRUNING has resigned as chief engineer of the Ohio State Highway Department to enter the employ of the Ohio Paving Brick Manufacturers' Association.

R. M. NORTON, county engineer of Sacramento Co., Cal., has resigned to become county engineer of San Diego Co., Cal. W. S. Caruthers has secured a year's leave of absence as division engineer of Division 3, California State Highway Commission, to fill Mr. Norton's former position with Sacramento Co., while G. R. Winslow, first assistant engineer of the California State Highway Commission, replaces Mr. Caruthers as division engineer, Division 3.

R. M. WHITE, formerly division engineer of the Delaware, Lackawanna & Western R.R. at Buffalo, and later superintendent of the Bangor & Portland Division, has been appointed superintendent of the Morris & Essex Division of the same road, with office in Hoboken. During the war Mr. White was lieutenant-colonel in charge of Section C of the Construction Division.

WILLIAM N. BOYD has been appointed chief engineer of the Detroit, Bay City & Western and the Port Huron Southern railroads with headquarters at Bay City, Mich.

JOHN C. HOYT, chief of the division of surface waters of the U. S. Geological Survey, sails early in March for Honolulu where he will confer with the district engineers in Hawaii regarding the surface waters investigations being conducted there. The divisions of surface waters and ground waters of the Geological Survey have been co-operating with the Hawaiian

government in producing an adequate and pure water supply.

AUBREY G. HAVEN of Brooklyn, N. Y., has been appointed as real estate engineer in charge of the valuation of real estate and right-of-way for the Gulf, Mobile & Northern R.R. For many years past Mr. Haven has been engaged in similar work for the B. & O. R.R., the Atlantic Coast Line R.R., the Canadian-Pacific Ry., the Lehigh Valley R.R., and the New York Central & Hudson River R.R.

BENJAMIN F. WOOD, formerly chief engineer of the electrical division of the Pennsylvania R.R., and more recently head of B. F. Wood, Engineers, Inc., announces a change in the name of the latter firm to Wood, Hulse, Yates Co., Inc. Other members of the firm are William S. Hulse and Eugene A. Yates.

W. E. HERRING, water-power engineer of the United States Forestry Service in the district of Washington, Oregon and Alaska, and later industrial manager for the Puget Sound Traction, Light & Power Co., has joined the engineering staff of Stone & Webster.

AUSTIN H. REEVES has opened an office for practice as consulting civil engineer at Charlotte, N. C.

H. C. COMPTON, formerly county roadmaster, Clackamas County, Oregon, has been appointed District Highway Engineer with headquarters at Boring, Oregon. H. A. Rand succeeds Mr. Compton as county roadmaster.

F. M. LANE has been appointed engineer in charge of the Woodland, Wash., diking district, Cowlitz County, with headquarters at Woodland.

J. F. BUCKLEY of Oakland, Cal., has been chosen to represent the Port of Portland Commission of Portland, Oregon, on a trade mission to the Orient.

ROSWELL D. TRIMBLE has announced his resignation from Winston & Co. of Richmond, Va., and New York City, and the organization of R. D. Trimble & Co. of Richmond. The new firm will carry on a general consulting and constructing engineering practice.

HOWARD H. BARNETT, for the past three years city engineer of Pontiac, Mich., has resigned to resume private practice as a consulting engineer. Mr. Barnett not only executed a very large construction program for Pontiac during his retention by that city, but he laid out $2,000,000 worth of work to be done during this year and next. His successor as city engineer is L. J. Lenhardt recently in the engineering department of Detroit, and assistant engineer with Clarence H. Hubbell, consulting engineer of that city.

P. M. LAU has resigned as highway engineer, Oakland Co., Mich., to enter the contracting field in highway work.

FRANK M. CLARK, engineering superintendent in charge of paving for the Barrett Co., Ltd., in the Maritime Provinces of Canada, has resigned to assume the duties of his appointment as assistant chief engineer of the Nova Scotia Highway Department in charge of highway construction. His headquarters are now at Halifax, N. S. J. W. Roland is chief engineer of the department.

H. H. WADSWORTH, who has been with the Engineer Department, U. S. A., since 1897 and since 1905 chief assistant engineer of the California Debris Commission, has severed his Government connection and opened an office in San Francisco for consulting and general engineering practice. He will specialize in works for the utilization of water and for flood protection. During the war Mr. Wadsworth held the rank of Major. For two and one-half years he was connected with the advisory board of engineers appointed by the President to advise the Secretary of the Interior on San Francisco's plans for developing a source of water supply.

OBITUARY

ANDREW C. HANSEN, city engineer of Los Angeles, Cal., died at his home there on Feb. 9, 1920, of pneumonia. Andrew Christian Hansen was born in Denmark in 1880. He came to this country with his parents when eleven months of age. The family took up residence in Sanger, Cal., and the boy worked his way through the University of California, graduating in 1902. His professional work as an engineer began with the United States Reclamation Service on the Klamath Falls and Yuma projects. In 1906 he was put in charge of the outfall sewer, then being built for the City of Los Angeles, whereon difficulties had been encountered and the work abandoned by the contractors. He carried this work through to a successful conclusion, and from there was transferred to the Los Angeles aqueduct, having charge of the Jawbone and Mojave divisions, the most difficult pieces of construction on the work. Next he became inspector of Public Works in the City of Los Angeles, and in 1913 was made chief deputy city engineer, being appointed city engineer in 1917 to fill a vacancy. Mr. Hansen was a member of the Am. Soc. C. E., and the A. A. E., and the Engineers and Architects Association and University Club of Los Angeles.

WALTER SHEPARD, formerly consulting engineer for the Boston & Albany R.R., died at his home in Dorchester, Mass., Feb. 8, 1920. Mr. Shepard was for forty years an engineer for the Boston & Albany R.R., retiring from that service in April, 1919. He was born in Dorchester in 1849, and graduated from Harvard University in the class of 1870. He then took a course in civil engineering at Massachusetts Institute of Technology, graduating in 1872. Upon graduation he entered the employ of the Boston & Albany, and rose through the various stages in the engineering department to that of principal assistant engineer. He was in charge of the construction of the South Station of Boston, for which he had made an exhaustive study of terminal problems, both in this country and abroad.

ROBERT MURDOCH WALKER, civil engineer and builder, died Feb. 7 at his home in Atlanta, Ga., at the age of fifty-six years. Mr. Walker was born in Columbia, S. C., in 1864. He was head of a large construction company with headquarters in Atlanta, which has built many of the principal edifices of that city.

ARTHUR TUFTS of Atlanta, Ga., one of the leading engineers and contractors of the South, died Feb. 23, at his Atlanta home at the age of 40. Influenza was the cause of his death. Mr. Tufts, who had resided in Atlanta most of his life, was the owner of the building and contracting business conducted there under his name. One of Mr. Tufts' most important undertakings was the construction of Camp Gordon for the government.

PAUL PARADIS, civil engineer of the Montreal Tramways Commission, died in Montreal, Que., Feb. 10. Mr. Paradis had for many years held important government positions in Western Canada.

ORLANDO W. NORCROSS, well known as a member of the contracting firm of Norcross Bros. of Worcester and Boston, died suddenly at his home in Worcester, Mass., Feb. 27, 1920. Mr. Norcross was identified with the construction in some of the largest contracts for buildings in the East.

ROBERT WAKEFIELD who died recently at his home in Portland, Ore., at the age of 74, was one of the Pacific Coast's pioneer contractors and engineers. He constructed many large municipal projects including a bridge across the Willamette River and a great part of the Portland water-supply system.

GEORGE ROMAINE OLNEY, civil engineer, died this week at his home in New York City. He was 77 years old and was born in Windham, N. Y. He took up law after graduation from college, but after practising for some time in Catskill studied civil engineering. He was engaged in construction work of the West Shore R.R. and later in the construction of New York city's aqueduct.

JAMES GAYLEY, first vice-president of the United States Steel Corporation from 1901 to 1908 and distinguished among the great steel men of the country for his knowledge of metallurgy, died Feb. 25 after an illness of several weeks in New York City.

J. W. KAERTH, for many years county surveyor of Colusa Co., Cal., and prominently identified with irri-

gation and reclamation work in the Sacramento Valley of California for the past 25 years, died on Feb. 12, at Colusa, aged 54 years.

JOHN LESTER MILLER, former resident engineer, Norfolk & Western R.R., county engineer, Ross Co., Ohio, city engineer Chillicothe, Ohio, died Feb. 14, 1920, from injury resulting from a fall. Mr. Miller, who was in charge of a $1,000,000 construction for the Meade Paper & Pulp Co. of Chilicothe when he died, was 33 years of age, and a graduate in civil engineering, University of Virginia.

LOREN R. MANVILLE, assistant engineer in the office of the engineer of structures, U. S. Railroad Administration, died in St. John's Riverside Hospital, Yonkers, N. Y., Feb. 12, after an illness of about six weeks, due to complications following an operation for appendicitis. Mr. Manville was born in Mason City, Iowa, on Jan. 31, 1886. He was graduated from the University of Michigan in 1912, receiving the degree of Civil Engineer in 1918. Upon the completion of his college course he went to New York and entered the employ of the New York Central as a bridge designer. On account of his exceptional ability he was rapidly promoted and soon became an assistant engineer in charge of working out the details and design of some of the most important bridges. Conspicuous among these bridges were two projects: the repair of the Harlem River drawbridge and the bridge carrying the New York and Ottawa over the St. Lawrence River at Cornwall, Quebec. The work at both of these bridges involved the repair or renewal of pins and presented problems of unusual difficulty which required special methods that were practically without precedent. The latter is described in the present issue of *Engineering News-Record*. He was greatly interested in engineering research, his most notable undertaking along this line being an investigation of the strength of timber beams, whose result was published in an article by him in *Engineering News-Record*. Others of his articles had been published previously in *Engineering News* prior to its consolidation with *Engineering Record*.

New Concrete Pressure Pipe Joint

A tight joint for concrete pressure pipe has been devised by Coleman Meriwether, Indianapolis, Ind., and will shortly be put on the market. The details of the joint are shown in the accompanying drawing. It consists of bell and spigot castings fastened to the reinforcement of the pipe, and beveled and machined so as to permit the introduction of a lead gasket which is driven home by a circumferential steel ring forced into place by bolts.

The bell casting is formed with a right-angle flange on the end with cored holes in the flange to receive the bolts. The recess in the bell casting to receive the lead pipe-calking gasket is cylindrical to 1 in. from its outer end and beveled for the rest of the depth at an angle of 30°. The spigot casting is machined to 4 in. from its outer end to allow expansion and contraction in contact with the lead pipe gasket.

When the pipe have been sufficiently cured to be laid, the steel ring welded at the ends is placed around the machined part of the spigot casting, and forced back nearly to the concrete. After the ring has been placed on the spigot casting, the lead pipe gasket which has been truly formed around mandrels and ends joined together, is then placed around the spigot casting up against the steel ring.

In laying, the spigot of one pipe is placed into the bell of the next pipe and brought up home. The lead packing ring and the steel calking ring are moved forward until the lead gasket has entered the recess. The cast-iron calking lugs with the holes filled with cup grease are then placed over the bolts and steel ring. The washers and nuts are then attached and the lead gasket bolted up tightly to form a water-tight expansion and contraction joint. After the joint has been made water-tight the outside recess in the concrete is to be filled with grout and the backfill placed.

Two such pipes recently tested were made on Dec. 26, 1919, steam-cured and placed together Dec. 31, 1919, filled with water Jan. 5, 1920, and pressures applied up to 45 lb. per square inch Jan. 8. The pipes were then emptied and again filled Jan. 26, and kept full until Jan. 31, when the pressure was gradually applied up to 115 lb. per square inch which was maintained for 15 minutes with no signs of leakage in the joint or the concrete.

TRADE PUBLICATIONS

The following companies have issued trade publications:

MEAD-MORRISON MANUFACTURING CO., East Boston, Mass., and Welland, Canada; catalog, 7½ x 10 in., 165 pages, illustrated; descriptive of a large line of hoisting machinery and accessories.

GRINNELL CO., Providence, R. I.; book, 8 x 10 in., 16 pages, illustrated; descriptive of the company's plants and services in the field of fire prevention, including descriptions of automatic sprinklers, industrial piping, heating and power equipment, fittings, pipes and valves.

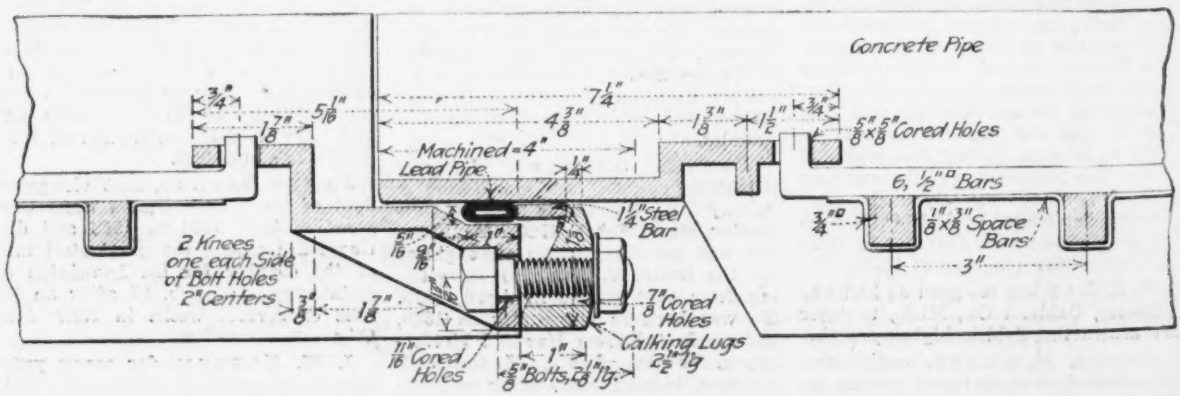
WESTINGHOUSE ELECTRIC & MFG. CO., Pittsburgh, Pa.; booklet, 5½ x 7½ in., 32 pages, illustrated; "Westinghouse Opportunities for Technical Graduates"; describes industrial, living and social conditions offered by the company.

GUARANTY TRUST CO. of New York, New York City; booklet, 6 x 9 in., 18 pages; "Belgium's Recovery" by E. L. Blount, tells of Belgium's economical "come-back."

LAKEWOOD ENGINEERING CO., Cleveland, O.; booklet, 8½ x 11 in., 32 pages, illustrated; mechanical description of the Tier-Lift truck and a description of its various uses.

BLAW-KNOX CO., Pittsburgh, Pa.; folder, 3½ x 6½ in., 8 pages, illustrated; describes Blaw steel forms for various concrete structures.

WORTHINGTON PUMP & MACHINERY CORP., New York City; booklet, 6 x 9 in., 115 pages, illustrated; describes Worthington condensing apparatus and auxiliary equipment.



SPECIAL JOINT FOR CONCRETE PRESSURE PIPE